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Correction of Frequency-Response Variations Caused by Magnetic-Head Wear

By KURT SINGER and MICHAEL RETTINGER

Wear on a magnetic-recording head reduces the front-gap pole-face depth and thereby produces an increase of the gap reluctance. This in turn produces a higher effective bias flux which has an erase action and thus tends to attenuate the high frequencies as they are being recorded on the recording medium. It is the purpose of the paper to present these performance variations as a function of the lowered inductance associated with head wear and to show how, simply through a correction of bias current, proper performance can be restored.

It has been noticed in the past that wear on a magnetic-recording head results in a decrease of high-frequency response of the overall magnetic recording-reproducing system and also in a change of head sensitivity. The information and data contained in this article explain the reasons for the change in frequency characteristic and offer a simple expedient for correcting the losses and thereby extending the useful life of magnetic heads.

While the benefits of a high-frequency bias current employed in magnetic recordings have been described in numerous publications, it is not frequently noted that the use of too much bias entails the loss of recorded high frequencies. This is due to an erase action produced by the bias flux at the front gap of the recording head. As the recording medium moves past the gap, it is subjected to a rapidly alternating magnetic field, which tends to restore the medium to its neutral or virginal state, wherein the magnetic dipoles are oriented heterogeneously. This effect is more pronounced for the high frequencies than for the lows and appears to be associated with the recorded wavelength.

Wear on a magnetic-recording head reduces the front-gap pole-face depth and thereby produces an increase of the gap reluctance. This in turn produces a higher effective bias flux which has, as noted above, an erase action and thus tends to attenuate the high frequencies as they are being recorded on the recording medium. It should be noted that this higher front-gap reluctance is due only to the decrease in front-gap pole-face depth and not to any widening of the gap, which with our type of

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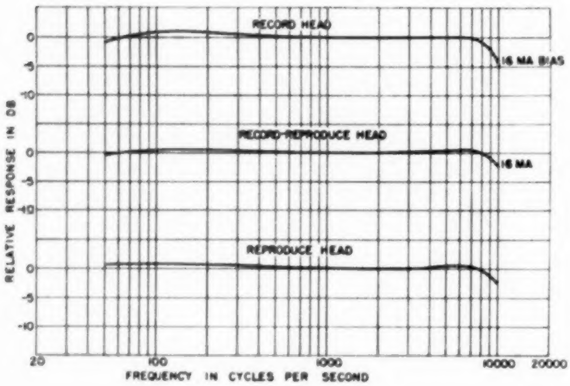

Fig. 1. Frequency characteristic at initial bias current head inductance 4.9 mh, 45 fpm.

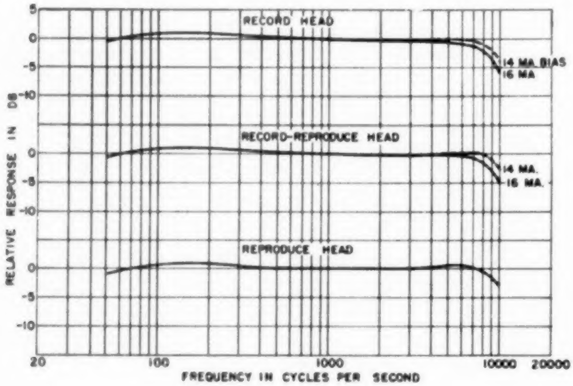

Fig. 2. Frequency characteristic vs. initial and optimum bias current head inductance 4.5 mh, 45 fpm.

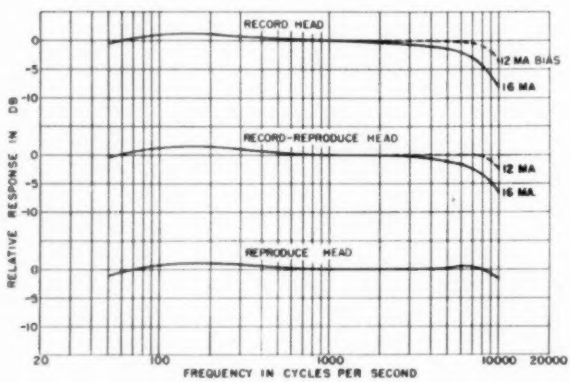

Fig. 3. Frequency characteristic vs. initial and optimum bias current head inductance 4.2 mh, 45 fpm.

magnetic-head construction remains constant.

To permit a ready evaluation of the test results, it is desirable to describe the method of testing. First, a frequency recording was made with an MI-10795-1 Head hereinafter called the test head. The film speed was 45 fpm and the initial bias current 16 ma at 68 kc. The recording was then reproduced on a similar head and the properly equalized output from it was taken as an indication of the performance of the test head as a record head. Next, the recording was reproduced on the test head and the output from it was taken as an indication of the performance of the test head as a combination record-reproduce head. A frequency film which had been made previously was then reproduced on the test head and the output from it was considered an indication of the performance of the test head as a reproduce head. The three frequency characteristics thus obtained are shown in Fig. 1. The top, center and bottom curves show the initial test-head performance as a record, record-reproduce and reproduce head, respectively.

The test head was then removed from the recorder, lapped until its inductance was lowered by 0.4 mh, that is, reduced from an initial 4.9 mh to 4.5 mh. The entire test was then repeated, thereby obtaining new performance data on part of the test head as a record, record-reproduce and as a reproduce head. It was noticed that the change in frequency response (loss of highs) resulting from the lowered inductance was greater when the head was used as a record head than when it was used as a reproduce head. To restore the frequency response of the record head to normal, the bias current had to be reduced to 14 ma. The frequency characteristics obtained from the test head with its inductance reduced to 4.5 mh are shown in Fig. 2. The upper and center curves show head performance as a record and record-reproduce head with the initial bias of 16 ma, and the reduced bias of 14 ma (dashed line). The test head was then removed again from its mount, lapped so that its inductance was lowered again by a certain amount, in this case from 4.5 to 4.2 mh, and the tests were repeated. The frequency characteristics obtained from this series of tests are shown in Fig. 3. Again it should be noted that the reduction of bias current to 12 ma for this head inductance of 4.2 mh restored head performance to normal. Figures 4, 5 and 6 depict the head performance for inductances of 3.85, 3.5 and 3.1 mh. These curves also show the change in bias current required to regain proper frequency characteristics.

Figure 7 shows the gradual loss in high frequencies as the recording-head inductance drops from 4.9 to 3.1 mh at a constant bias current of 16 ma.

When the region of maximum sensitivity bias of the record head over the range of inductances from 4.9 to 3.1 mh was investigated, it was noticed that the initial bias current of 16 ma and the reduced optimal bias currents in all cases represented bias currents corresponding to a value either equal to or slightly lower than maximum sensitivity bias. However, this statement should not be construed to mean that it is only necessary to adjust the bias current to maximum sensitivity bias to recover the lost high frequencies. This procedure would only result in an approximately normal performance. In order to compensate for head wear accurately, it is necessary to reduce the bias current experimentally to a value which will produce the initial frequency characteristic.

During these tests it was also noticed that a sensitivity change of the test head took place. The sensitivity variations are shown in Fig. 8. Zero sensitivity of the test head as a record head corresponds to the sensitivity of the head with its full inductance of 4.9 mh operating

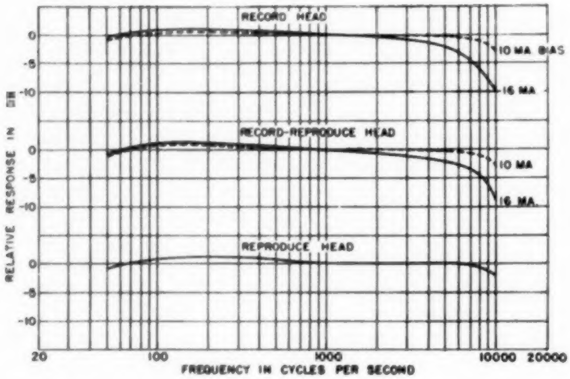

Fig. 4. Frequency characteristic vs. initial and optimum bias current head inductance 3.85 mh, 45 fpm.

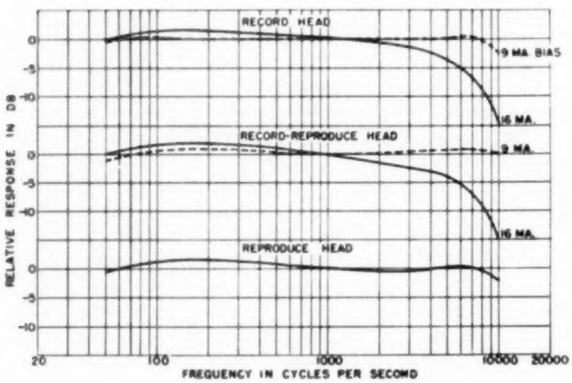

Fig. 5. Frequency characteristic vs. initial and optimum bias current head inductance 3.5 mh, 45 fpm.

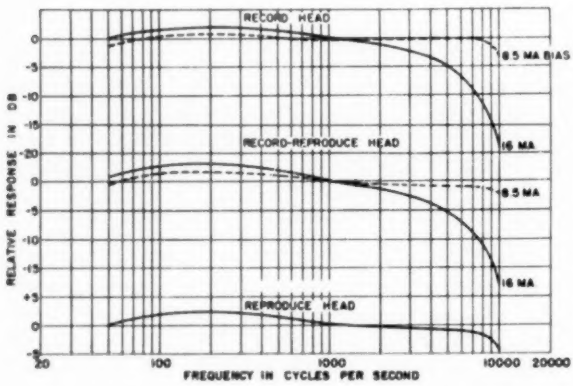

Fig. 6. Frequency characteristic vs. initial and optimum bias current head inductance 3.1 mh, 45 fpm.

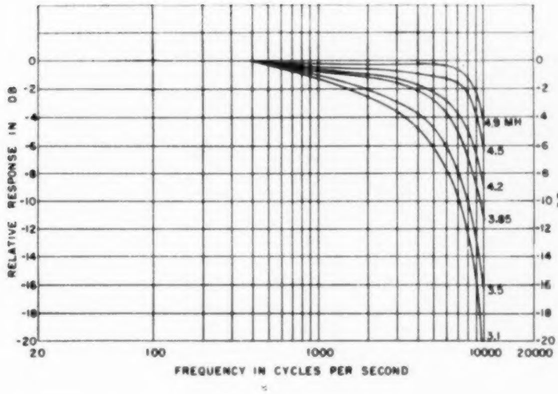

Fig. 7. Frequency response vs. inductance of recording head measured at constant bias of 16 ma. 45 fpm.

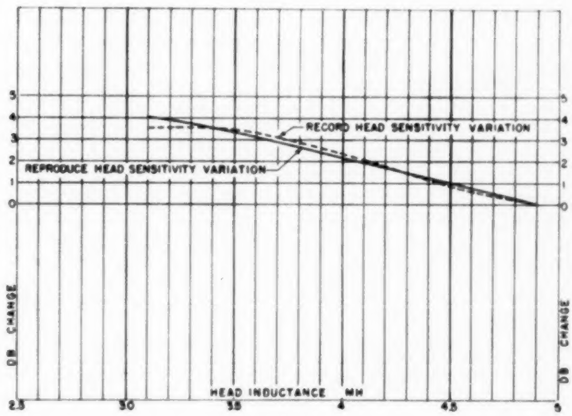

Fig. 8. Head inductance vs. sensitivity change, 45 fpm, 400 cycles.

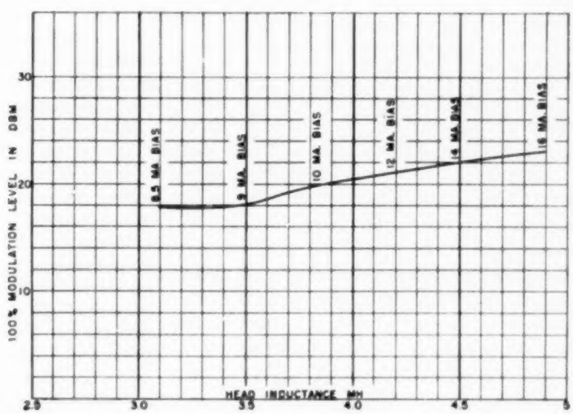

Fig. 9. Head inductance vs. optimum bias current vs. 100% modulation level, 400 cycles, 45 fpm.

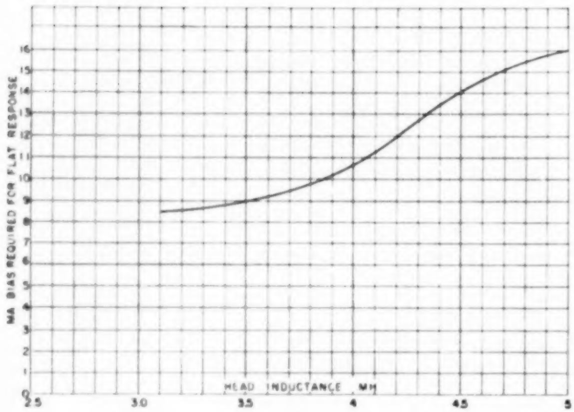

Fig. 10. Head inductance vs. optimum bias current, 45 fpm.

at a bias current of 16 ma. It should be noted that as the head inductance is decreased, and the head sensitivity increased, it is necessary in order to obtain 100% modulation (approximately 2.5% distortion at 400 cycles), that the signal input to the head (signal current) be reduced by the amount shown on this curve. In exploring the performance of the test head as a reproduce head, zero sensitivity was assumed as the sensitivity of the head with an inductance of 4.9 mh. As the head inductance was lowered, the output from the head increased by the amount shown on this curve.

Figure 9 shows the change in the 100% modulation level that was noted as the head inductance was decreased and the bias current readjusted for satisfactory high-frequency performance.

Figure 10 has been included to show approximate values of optimum bias currents which can be used in an initial attempt of correcting for high-frequency loss by the record head when the head inductance has been reduced due to head wear. It must be understood that this curve can only be offered as an approximation toward the desired optimal bias current. Minor deviations from it may exist in individual cases.

All the tests described above have been made at a film speed of 45 fpm. The attenuation of recorded high frequencies due to magnetic-head wear at other film speeds will have the same trend, although it does not necessarily follow that the same patterns, obtained with a 45-fpm film speed, will result. However, practice has shown that in all cases it has been possible to regain lost high frequencies through a reduction of bias current.

We would like to inject a note of caution, namely, that each change in bias current necessitates the re-establishment of the 100% modulation recording level to avoid overloads and resultant increase in distortion.

Discussion

Anon: I would like to know if you're getting any variation in the signal-to-noise ratio out of your tape with this output variation, a decrease of high-frequency bias and concurrently of modulation level.

Mr. Singer: No, we have not noticed any deterioration of signal-to-noise ratio. The signal-to-noise ratio essentially stays the same, as with the initial bias and the initial modulation level.

Anon: Because, of course, the maximum level that you get from your tape must decrease definitely. Then, suppose you are recording 100% as established by 2.5% distortion. You recorded with a normal head and normal conditions — 16 ma and whatever db level you're using. Then you record a second tape at a lower general

level with another head. If you produce these two tapes, both recorded at 100%, you must evidently get a lower level out of the second tape than you got from the first tape.

Mr. Singer: No, we do not obtain any lower level from the second tape, because the magnetization that is inherent in the film will be the same. If they're going to work at the same bias sensitivity, they will also have the same voice sensitivity. As the head wears down and the gap reluctance increases, its flux fringing which increases is applicable to the bias flux as well as to the modulation flux. So, essentially, we get the same output. I don't think we noticed more than maybe a db output variation over the entire range of head inductances and bias correction.

George Lewin (Signal Corps Pictorial Center): Can you give us a rough idea of how many feet of film you run through before you reach the extreme values of head wear that you indicate here?

Mr. Singer: Perhaps Mr. Rettinger is in a better position to answer this question?

Mr. Rettinger: The head was lapped down by hand on a 600 grit silica carbide paper.

Mr. Lewin: Yes, I understand that. But you must have some idea as to how much equivalent footage is represented.

Mr. Rettinger: In general, you mean?

Mr. Lewin: Yes, that's right.

Mr. Rettinger: It depends on a number of factors such as film speed, type of tape, film tension, etc. On a triple-track head, in one of the studios for instance, we were able to pass over 3 million feet of film before the head inductances had lowered to 3 mh.

Mr. Lewin: Which is the extreme amount that you showed here. Three million feet of film, you say, is roughly the equivalent of the maximum amount of wear that you showed?

Mr. Rettinger: That's right.

Anon: What sort of life should we expect, roughly, from the reproducing heads in terms of feet of film that run over them and also near the end of that life, what is to be expected with regard to the output level and the change in frequency response, if any?

Mr. Rettinger: As I just said, one may expect at least 3 million feet of film to pass over the head before its inductance has dropped to 3 mh. That is, under the condition that we call the tight-loop system. Where there's less film tension on a head, the life of the head may be extended. How long? I don't have that information available. With regard to sensitivity variation, I think that was indicated on the slides. There would be approximately a 3-db gain in head sensitivity when the inductance has been lowered from 5 to 3 mh.

Anon: Would Mr. Rettinger continue and indicate the change in the frequency response near the end of reproducer head life?

Mr. Rettinger: That was shown on the curve. There's very little change in the frequency response of the reproduce head down to, let us say, 3 mh. After that when the gap begins to open up, naturally there will be a rapid falling off of high-frequency response.

Anon: Is what you said applicable in general to most any make of reproduce head that we might find in theaters in the near future, as far as we know?

Mr. Rettinger: Not necessarily. It depends on the way the head is constructed. If the front gap is built so that it remains of constant length as the head wears down, I would expect very little change in frequency response. But if the head is built so that the front gap will lengthen as the head is worn down, then, naturally, there will be a loss of high frequency. Our heads are built so that the gap length remains constant.

16mm Motion-Picture Theater Installations Aboard Naval Vessels

By PHILIP M. COWETT

The Navy's shipboard motion-picture installations, involving special location problems calling for equipment of great flexibility, and acoustic problems complicated by high noise levels, are briefly described.

We have presented to this Society at various times the Navy story regarding the problems incurred in the procurement of film of adequate quality to meet the needs aboard ship. We have never, however, described before this Society the theater installations utilizing 16mm equipment aboard Navy vessels located throughout the world. These installations generally break down into categories of ships such as destroyers, aircraft carriers, battleships — each with its own specific problem. The purpose of this paper is to describe some of these installations and set forth the Navy's program at this time with regard to 16mm film and its professional use as a serious entertainment medium.

Following the last world war, a survey was made of the various overseas shore-based activities and ships to determine whether they desired to continue with the use of 35mm film and equipment or convert to the equivalent in 16mm with its obvious advantages with regard to transportation, handling, lack of fire hazard and so forth. This resulted in the report from the various polled activities that 16mm would be very desirable from the standpoint of naval use if equipment could be procured that would match the 35mm equipment characteristics.

Obtaining adequate equipment became a separate project which resulted in the development of two projectors meeting identical performance requisites. As to the equipments themselves, they have been described in the paper presented before the Society by Orr and Cowett in 1951.[1] Very little more need be added as to their performance.

As may be realized, a naval vessel is designed and constructed for one purpose — and that purpose, unfortunately for the motion-picture viewer, is not the showing of motion pictures. Since nothing is allowed to take place aboard ship which will interfere with the prime mission of the ship, our activities must accommodate themselves in any manner possible. One thing, however, becomes readily apparent, and that is the absence

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of acoustic treatment in any part of the ship. Therefore, there is really no best location for the evening show.

The first, or simplest type of installation, is that to be found aboard a destroyer or lesser craft. In this case the particular vessel is assigned a standard portable equipment, comprising a projector, 20-w amplifier, and 25-w loudspeaker. Individual ships sometimes manufacture portable bases for themselves, but none are provided as an allowance item. Figure 1 shows a single equipment (except for the loudspeaker) on board an LST.

Since the distances of throw are varied and limited, and the availability of permanent locations for the projection of film is nonexistent, it is essential that the equipment be easily portable. In good weather the shows are generally projected topside under the stars where high ambient noises are the rule. The projector, mounted on a steel stand, which is generally lashed to the deck, is set up in the most suitable location for the particular vessel, between 50 and 175 ft from the screen which measures approximately 9 ft 6 in. in width. With this vibrating platform as a projection booth preparations for the evening show go on. Vibration is due to the fact that on many types of vessels one of the two propeller shafts of the ship passes almost directly beneath the point where the projector is set up. Interconnection between the various units is established and the show is ready to start.

Of course the portable direct radiator type loudspeaker is mounted as high as possible close to the screen in order that adequate sound coverage may be obtained. There is not much in the way of height around the screen except the screen frame itself, which may or may not be able to support extra weight, since the screen acts as a sail and additional weight could cause it to buckle completely. When the ship is traveling by itself, with no particular time schedule for arriving at any one particular port, or where a ship can make up lost time, the Commanding Officer will normally reduce the speed of the ship to fifteen knots or less or even change course for the duration of the show. This permits a properly lashed down screen to remain in place without too much flapping.

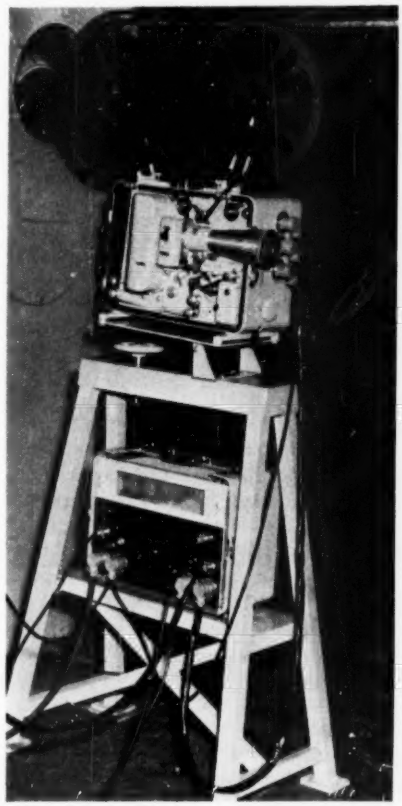


Fig. 1. Portable projector and amplifier.

It has been stated that two projection equipments had been developed—one a 20-w unit and the other a 5-w system.

The 5-w unit is aboard ship for training purposes, since a vessel of destroyer size is not large enough to warrant two projection equipments for entertain-

ment purposes alone. There is, however, a definite advantage in the use of even one 16mm equipment as compared with the 35mm, since we have to change reels only once every 45 or 50 min, whereas with 35mm, reel changing is much more frequent.

The 5-w equipment is designed with changeover facilities as is the 20-w equipment previously mentioned. Since both the 5-w and 20-w equipments have identical characteristics[2] and identical inputs and outputs including plugs and receptacles, the two can be interconnected in such a manner that a dual show may be given, without stopping the projectors for changing reels, and thereby accomplishing instantaneous changeover in the same manner as do professional 35mm equipments. In this instance the outputs of both projectors feed into the 20-w amplifier, and that 20-w amplifier provides exciter supply for both the 5-w and 20-w projection equipments, the 5-w amplifier being isolated.

Aboard larger vessels, such as a battleship or cruiser, a booth installation is involved. As in the previous instance, the high ambient noise still governs, and the same obstacles exist with regard to securing satisfactory sound distribution topside. Cross winds, engine-room blower noises, noise of the ship underway—all act to hinder the intelligibility of sound to a maximum extent. Of course, the effects of the moon on the picture are also noticeable.

Figure 2 shows a typical shipboard booth installation. The booth is mounted generally just abaft the main mast structure. The screen is located topside at the fantail, or stern of the vessel, and in some cases the distance between the only possible location of the projection booth and the only possible location of the screen is in excess of 200 ft. This installation consists of the following components: two projectors operating as a dual system mounted on specially designed projector stands, which include tilt plates, as in 35mm equipments, and mounting places below the projectors for the amplifiers. In addition a monitor loudspeaker, record player, film stowage space, rewind facilities, etc., are also available.

Changeover facilities are provided as in the installation previously described. The two standard Navy 20-w amplifiers are bridged at the front ends through telephone-type jacks. This allows a supply of an effective 40 w of power to the loudspeaker system located below on the main deck. Figure 3 shows the circuits involved in a cruiser installation.

Since the theater areas in ships of this type must be relatively long, as compared to their widths, and because of the various cross winds and miscellaneous noises encountered, it was necessary that a loudspeaker installation be designed especially for this type of ship. There is permanent ship's wiring between the projection booth and the loudspeakers themselves. The loudspeaker installation consists of two horns, or trumpet-type loudspeakers, mounted on the topmost corner sections of the husky screen frame. These horns are tilted to cover approximately the rear portion of the audience. They are parallel connected to one of the 20-w amplifiers in the booth which independently controls the volume and tone control characteristics of the sound from these particular loudspeakers. Portable-type direct radiator loudspeakers, previously mentioned, are mounted about halfway up on either side of the screen frame. These are tilted in the same manner as the horns; however, they cover only the front portion of the audience. They too are separately controlled by their own individual amplifier. The loudspeaker installation can be seen in Fig. 4. With this type of system the Navy endeavors to provide good quality sound, or as good sound as we can achieve under the particular topside conditions.

When the show is over the four loud-

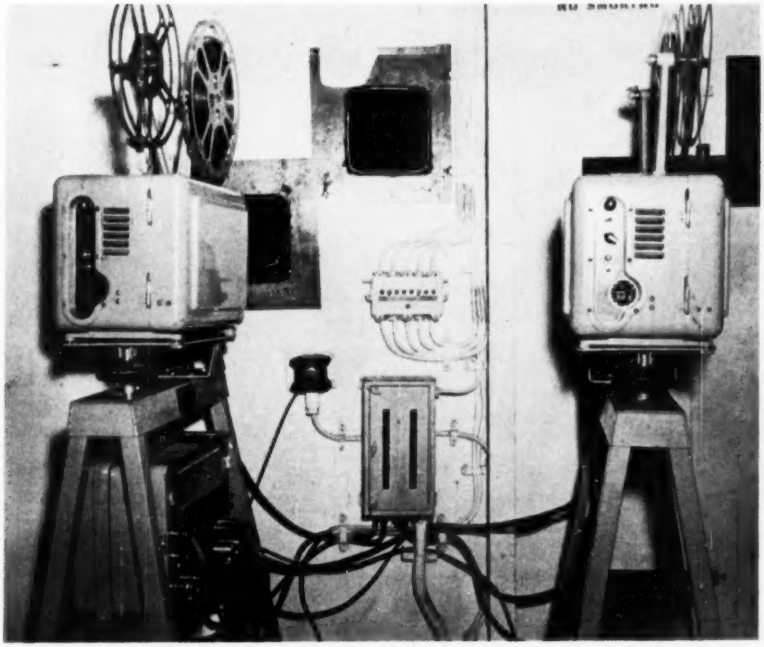


Fig. 2. 16mm shipboard booth installation (*Official Photograph,* **U.S. Navy**).

speakers and the screen with frame are completely dismantled and stowed away in assigned spaces until the following evening. During bad weather, projectors used generally for training purposes, the 5-w unit previously mentioned, or even the 20-w booth equipment can be taken into the wardroom, the crew's mess, or any other interior space and a reasonably good show given.

Projection below deck involves problems of steel bulkheads, decks, overheads, and so forth, which may result in some reverberation. The size of the audience is depended upon to deaden the sound. During inside shows dual operation of the projection equipments is not usually feasible in view of the fact that spaces are too small to hold the entire audience at one time. Therefore, shows are held simultaneously in several different compartments. Each show cannot start at the same time since reels must be passed from one projection area to the other.

A third type of installation would be that on an aircraft carrier, where extremely bad acoustical conditions result in a completely different approach to sound problems. The show, first of all, is presented in one of the hangar areas, normally used for the stowage and repair of aircraft. In some ships such an area is approximately 100 ft in width, 180 ft in length and 18 ft in height. The booth is mounted just below the overhead at one end of the area and projection is toward one of the hangar bay doors on which an 18-ft lace and grommet screen is mounted. A typical motion-picture hangar is shown in Fig. 5.

Projection distances of approximately 170 ft are average in our largest carriers. The projection booth is about the same as that on a battleship or cruiser — about

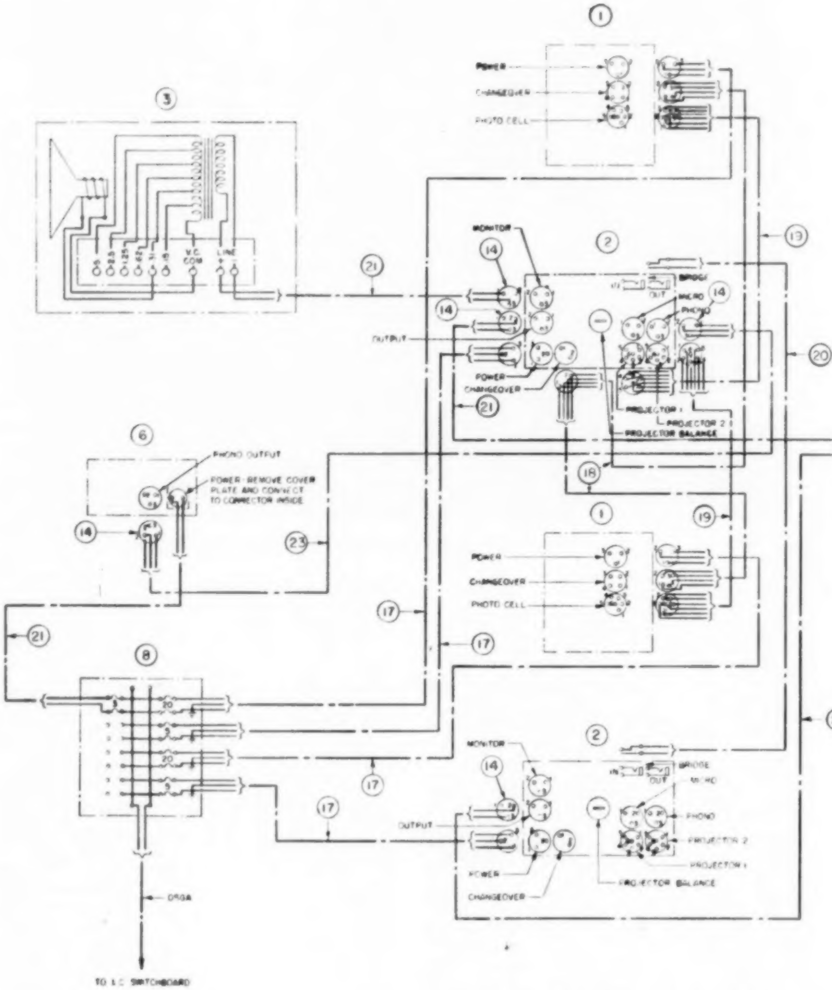
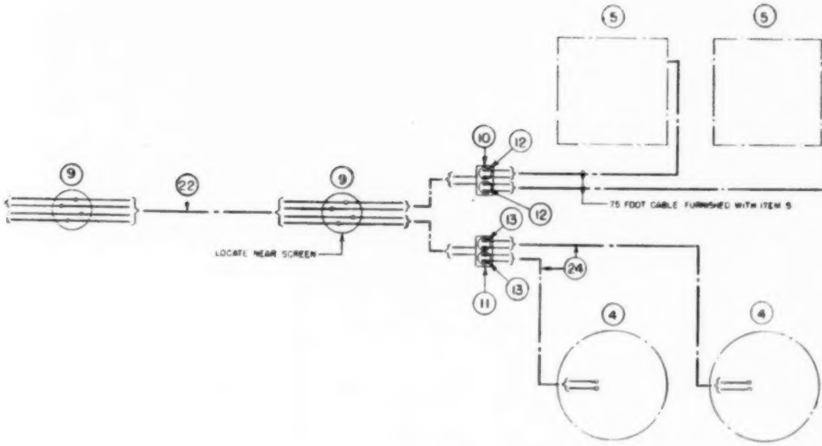


Fig. 3. Cruiser installation electrical wiring layout.



List of Material—Quantities for One Ship

Item No.	*Name*	*Qty.*	*Item No.*	*Name*	*Qty.*
1	Projector	2	15	Blkhd. mtg. bracket for sound reprod.	1
2	Amplifier	2	16	Studs for mtg. item nos. 3 and 15	8
3	Loudspeaker, monitor	1	17	Power cable assembly	4
4	Loudspeaker, horn type	2	18	Changeover cable assembly	1
5	Loudspeaker	2	19	Photoelect. cell cable assembly	2
6	Sound reproducer	1	20	Amplifier bridging cable assembly	1
7	Projector mounting base	2	21	TTHFWA $1\frac{1}{2}$ cable, lengths as required	4
8	Distribution box	1	22	TTHFWA 3 cable, length as required	1
9	Branch box	2	23	Cable, shielded, 2 cond., length as required	1
10	Receptacle, double, W.T.	1	24	Cable, DCOP-2, length 75 ft	2
11	Jack box, W.T., telephone	1	25	Mtg. bracket for type IC/QDM loudspeaker	2
12	Plug, receptacle, SBM	2			
13	Plug, telephone	2			
14	Plug, three connection	5			

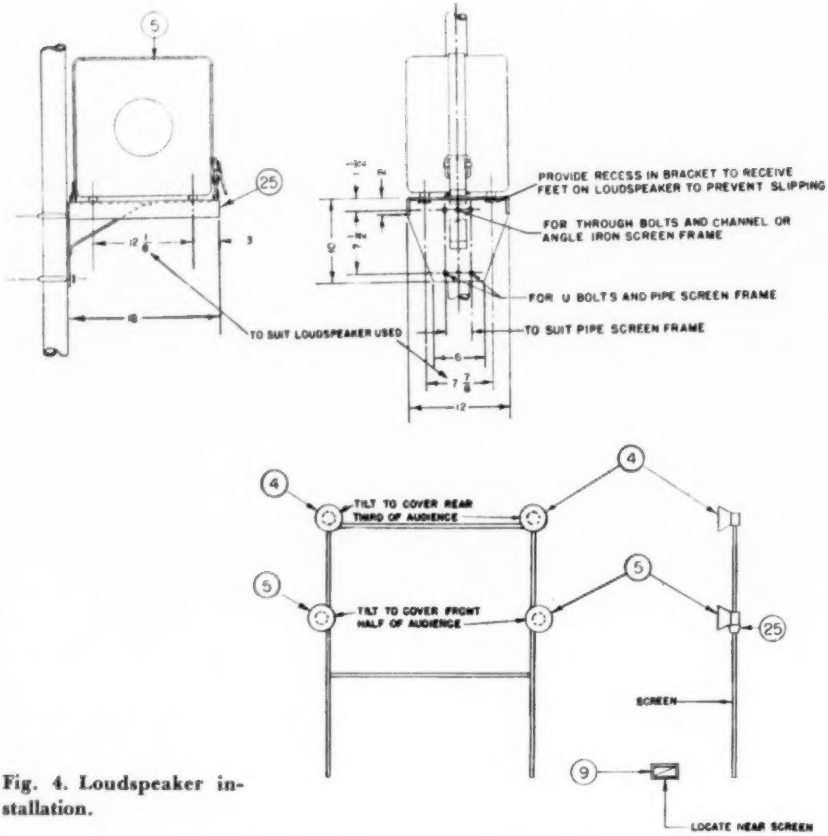


Fig. 4. Loudspeaker installation.

8 ft wide by 10 ft deep by 7 ft high. It contains a rewind table, a little stowage space, record player, and so forth.

The loudspeaker system is, however, completely different from any of the other systems used. Instead of the portable loudspeakers, a number of 12-in. loudspeakers in one-cubic-foot enclosures are mounted to the overhead and spaced approximately on 9-ft centers. Carriers of the *Midway* class have approximately 36 loudspeakers mounted to the overhead (Fig. 6). They are each tilted 20° toward the audience in order to minimize the reverberation which might be caused by the sound bouncing on the steel deck between rows of seats. As can be seen by the loudspeaker arrangement, space is allowed for a passageway in the middle of the audience. All loudspeakers are terminated in a switch control panel in the booth so that the quantity of loudspeakers on at any one time may be adjusted to the size of the audience. Advantage is taken of the sound deadening capacity of the audience and more loudspeakers are therefore connected as the crowd grows. This is a real advantage and allows maximum intelligibility from sound to be obtained. The loudspeaker system is powered by a

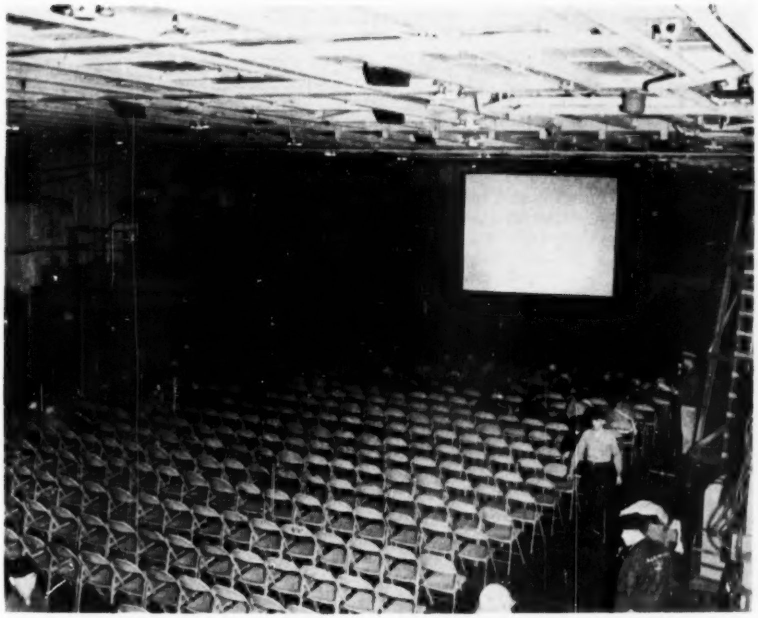


Fig. 5. **Motion-picture hangar area, U.S.S. Oriskany (CVA34)** (*Official Photograph*, **U.S. Navy**).

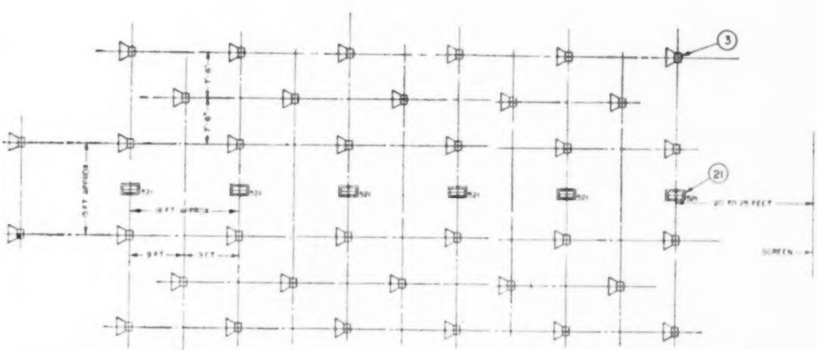
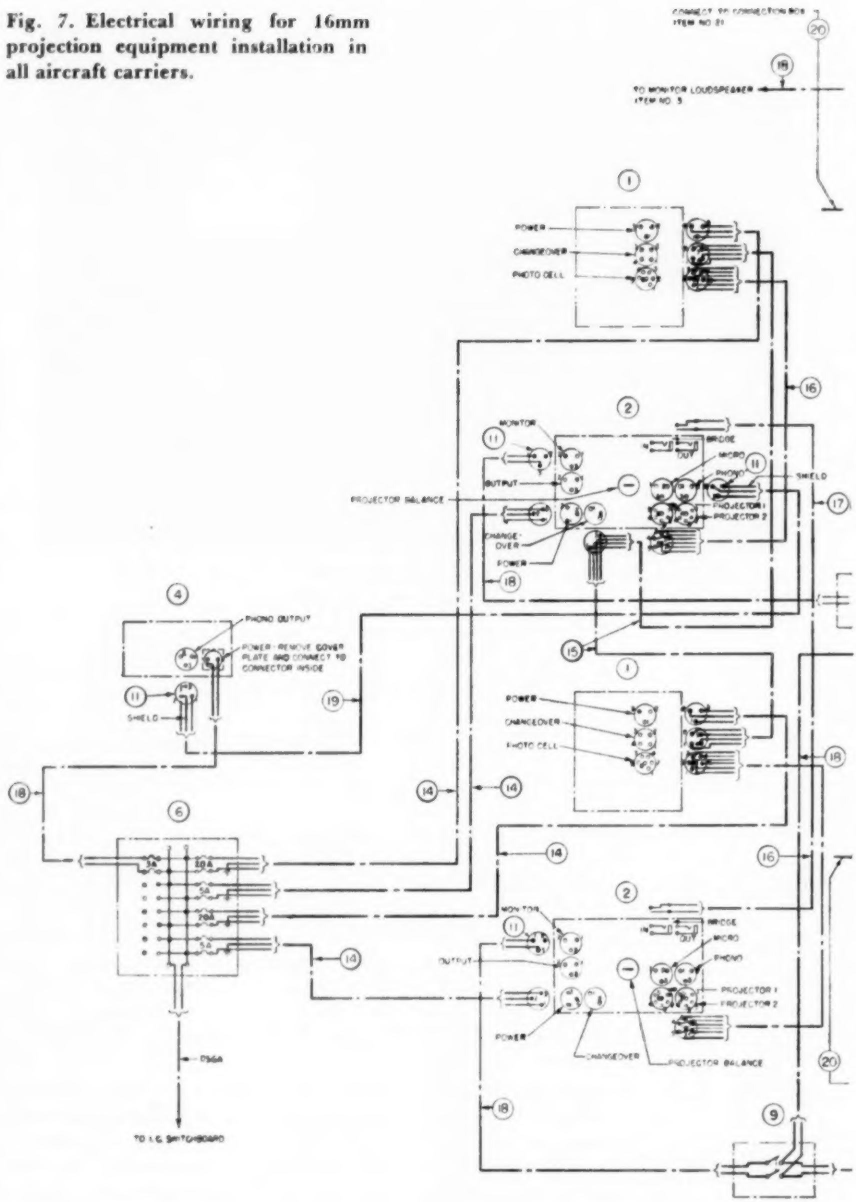
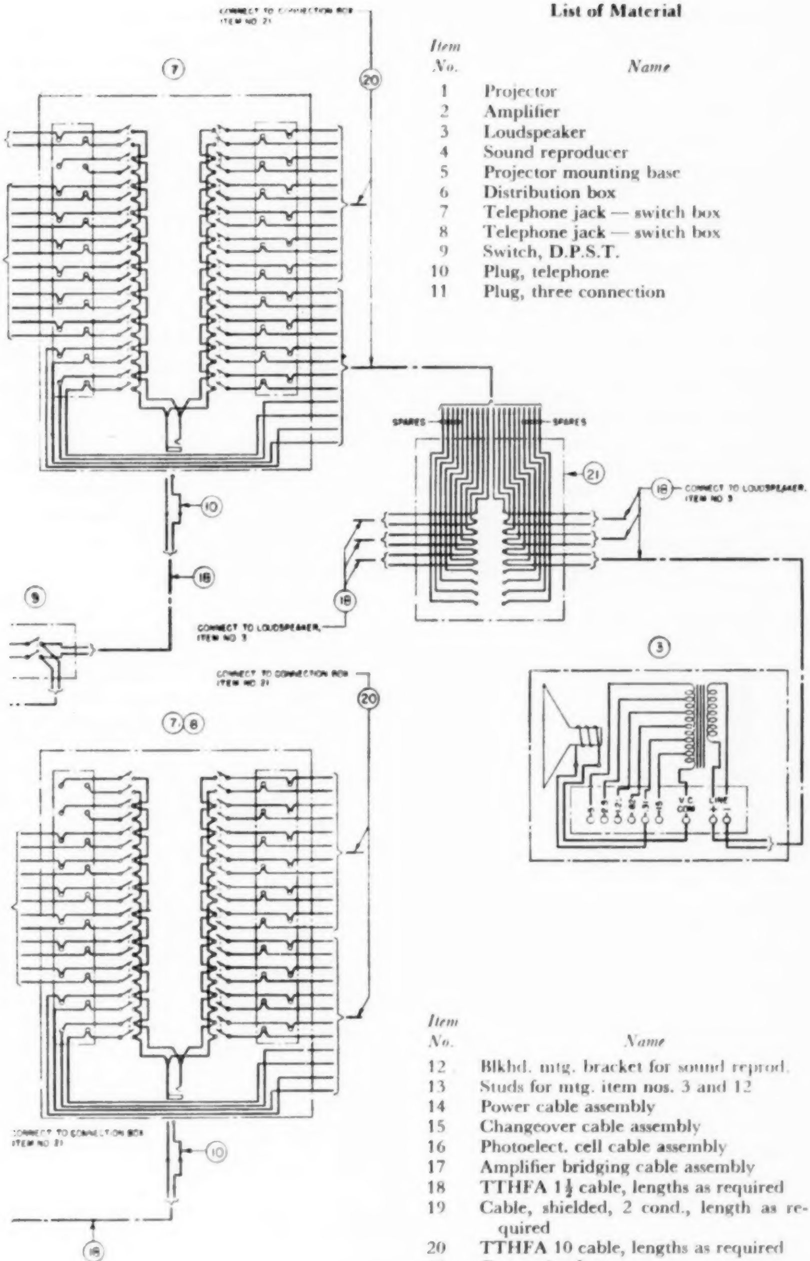


Fig. 6. Overhead loudspeaker layout for U.S.S. Midway class aircraft carrier.

constant voltage of approximately 100 v. Each loudspeaker enclosure contains a transformer which permits the sound output from any one particular loudspeaker to be adjusted depending upon the noise level of the area in which the loudspeaker is located. This, therefore, permits an even sound distribution to reach the entire audience regardless of the noise level surrounding any one person. It is obvious, however, that high ambient noises of 80 to 90 db, and

Fig. 7. Electrical wiring for 16mm projection equipment installation in all aircraft carriers.





List of Material

Item No.	*Name*
1	Projector
2	Amplifier
3	Loudspeaker
4	Sound reproducer
5	Projector mounting base
6	Distribution box
7	Telephone jack — switch box
8	Telephone jack — switch box
9	Switch, D.P.S.T.
10	Plug, telephone
11	Plug, three connection

Item No.	*Name*
12	Blkhd. mtg. bracket for sound reprod.
13	Studs for mtg. item nos. 3 and 12
14	Power cable assembly
15	Changeover cable assembly
16	Photoelect. cell cable assembly
17	Amplifier bridging cable assembly
18	TTHFA 1½ cable, lengths as required
19	Cable, shielded, 2 cond., length as required
20	TTHFA 10 cable, lengths as required
21	Connection box

reflections and reverberations in the projection area provide serious obstacles to the hearing of highly intelligible sound.

This situation, however, is not unlike that in many industrial areas where loudspeakers are used for public announcing involving coverage over a wide area of enclosed space. Experiments are continually being made to solve the acoustic problems involved. Various types of loudspeakers and loudspeaker systems are being tested in order to procure a more satisfactory final result.

A perfect theater can never result from the efforts made in this direction since the spaces allocated for motion pictures on ships have to fill their primary combat functions first, and can be adapted only secondarily for motion pictures. This, then, means that sound deadening material must be held to a minimum. Inflammable materials are absolutely out, no matter how good their acoustical properties may be.

Only one 20-w amplifier is used to cover the hangar area and to feed the booth monitor loudspeaker. From Fig. 7 it will be seen that both projectors can be fed to one or the other of the amplifiers. Two projectors feeding into one amplifier can be instantaneously shifted to the input of the stand-by amplifier in the event of the failure of the working amplifier. Should other peculiar conditions arise, each projector may feed into its own amplifier with both amplifiers individually feeding into the same overhead loudspeaker system. The switches which accomplish this change are identified by the numeral 9 in the center of the figure. In this manner we have attempted to provide a system of maximum flexibility because the conditions of use are subject to change without notice, depending almost entirely upon the number of persons attending the show; that is to say, of the amount of acoustic or sound absorption material present in the hangar bay area. This, of course, would be in addition to the change of film itself.

References

1. Lowell O. Orr and Philip M. Cowett "Desirable characteristics of 16mm entertainment film for naval use," *Jour. SMPTE, 58:* 245–258, Mar. 1952.
2. "Tentative recommendations for 16mm review rooms and reproducing equipment," *Jour. SMPTE, 56:* 116–122, Jan. 1951.

A First-Order Theory of Diffuse Reflecting and Transmitting Surfaces

By ARMIN J. HILL

Intensity of light emitted or reflected from a surface in accordance with Lambert's law varies in proportion to the cosine of the angle between the direction of the light beam and the normal to the surface. With many surfaces which do not follow this law, it is possible to approximate the variation of intensity with some power of the cosine. When such an approximation can be made, relatively simple relationships can be obtained for luminance (brightness), emittance and related factors. Use of this approach may take some of the mystery out of such problems as the determination of screen brightness and a study of transmission characteristics of process screens.

Lambert's law, which states that the intensity of light emitted from a perfectly diffusing radiator is proportional to the cosine of the angle between the normal to the emitting surface and the direction in which the intensity is measured, provides a simple mathematical basis for treating luminous surfaces which radiate according to this law. Unfortunately, few surfaces are perfect diffusers and serious errors will result if the simple equations derived from Lambert's law are applied to them. Many of the reflecting and transmitting screens used in the motion-picture and television industries are, in fact, quite highly directional, though not enough so that they can be treated according to the laws governing specular reflection or direct transmission.

Considerable literature is available on the theory of radiation transfer and on the processes by which light is diffused and scattered as it traverses various media. Most of this has approached the problem from too fundamental a viewpoint, however, to provide workable equations by means of which "partial diffusion" might be treated. This paper suggests an approach which is almost entirely empirical, based upon experimental tests on transmitting and reflecting screens, disregarding completely the processes by which this transmission or reflection takes place. These processes are therefore treated exactly as they are in applications of Lambert's law. The slight modification of the equations does not prevent, in most cases, an extension of the ideas

Presented on October 9, 1952, at the Society's Convention at Washington, D.C., by Armin J. Hill, Motion Picture Research Council, 1421 North Western Ave., Hollywood 27, Calif.
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based on this useful law to include directional screens and to treat these screens in the simple manner otherwise only safely applicable to perfect diffusers.

In analyzing the characteristics of translucent screens used for background process projection, it was noticed that the fall-off of intensity with increasing angle from the normal would be closely approximated, not by a cosine curve as for a perfect diffuser, but by using some power of the cosine of the angle. To show how closely this approximation holds, Figs. 1a–d show experimental curves obtained by means of a goniophotometer on experimental screens analyzed by Dr. Herbert Meyer of the Motion Picture Research Council. (Data were taken according to requirements of A.S.T.M. Designation D636–43.) The dashed curves in each set represent suitably selected cosine power curves, with the selected power used as a "shape factor" and symbolized by the letter s. It is immediately apparent that except for very low intensities, the cosine curve matches the experimental curve within a few percent — in fact in most cases within the instrumental error of the goniophotometer. Since most of the errors at very low intensities tend to make the readings too high, actual fit may be even better than that shown by the diagrams.

This comparison was then tried on data for typical reflecting types of surfaces with results as shown in Figs. 2a–d.[1] It will be seen that within angles of interest for most photographic work, the approximations again are good within a few percent. Care must be used, of course, in applying these in such cases as the beaded screen where a considerable portion of the total flux is emitted at large angles, for in such cases relations involving this total flux will be seriously in error. However, the particularly important relations between intensity, luminance and illuminance will hold when only small angles are involved.

In the following formulae, notation follows that employed by Sears.[2]

Definitions:

- F, luminous flux;
- I, luminous intensity or flux per unit solid angle;
- B, luminance (brightness);
- E, illuminance or flux per unit area received at a surface; and
- L, luminous emittance or total flux emitted per unit area.

Defining equations:

$I = \dfrac{dF}{d\omega}$, where ω is solid angle with vertex at source;

$E = \dfrac{dF}{dA} = \dfrac{I\theta \cos\theta}{r^2}$, where θ is angle with normal to surface;

$B = \dfrac{\Delta I\theta}{\Delta A \cos\theta}$; and

$L = \dfrac{\Delta F}{\Delta A}$, F is total emitted flux.

The following equations compare intensity and brightness for a surface which follows Lambert's law, with one which is directional but for which the intensity falls off in proportion to some power s of the cosine of the angle with the normal to the surface.

Lambert Surface	*Directional Diffuser*
$I\theta = I_o \cos\theta$	$I\theta = I_o \cos^s\theta$
$B\theta = B_L$	$B\theta = B_D \cos^{s-1}\theta$

Here B_L represents the brightness of the Lambert surface, and B_D the normal brightness of the directional surface.

[1] Sources for these data were: (a) for sandblasted mirror, James R. Cameron, *Motion Picture Projection*, Cameron Publishing Co., Coral Gables, Fla., 4th ed., p. 199; (b) for others, Ellis W. D'Arcy and Gerhart Lessman (De Vry Corp.), "Objective evaluation of projection screens," presented on April 22, 1952, at the Society's Convention at Chicago.

[2] E. W. Sears, *Principles of Physics, Vol. 3 — Optics*, Addison-Wesley, Cambridge, Mass., 1948, 3d ed., chap. 13.

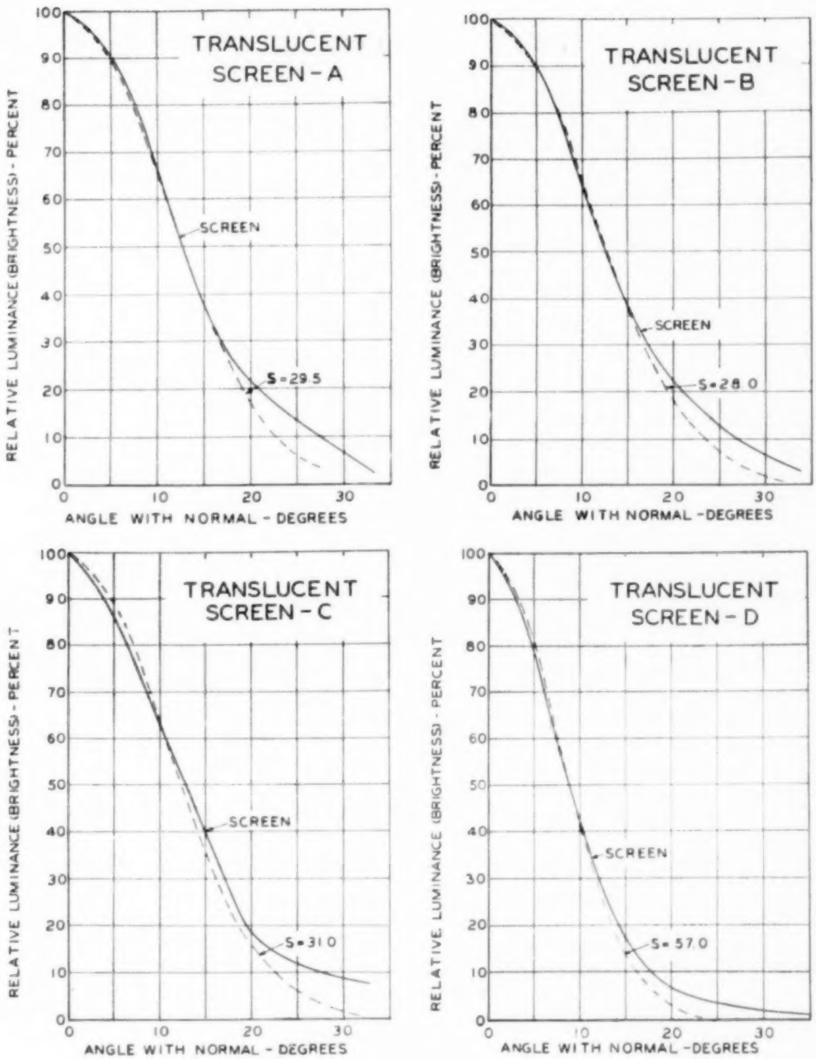

Fig. 1. Approximations of luminance fall-off for experimental translucent screens. Solid curves show experimental data, dashed curves show ratios of $B\theta/B_0$ obtained from the equation $B\theta = B_0 \cos^{s-1}\theta$.

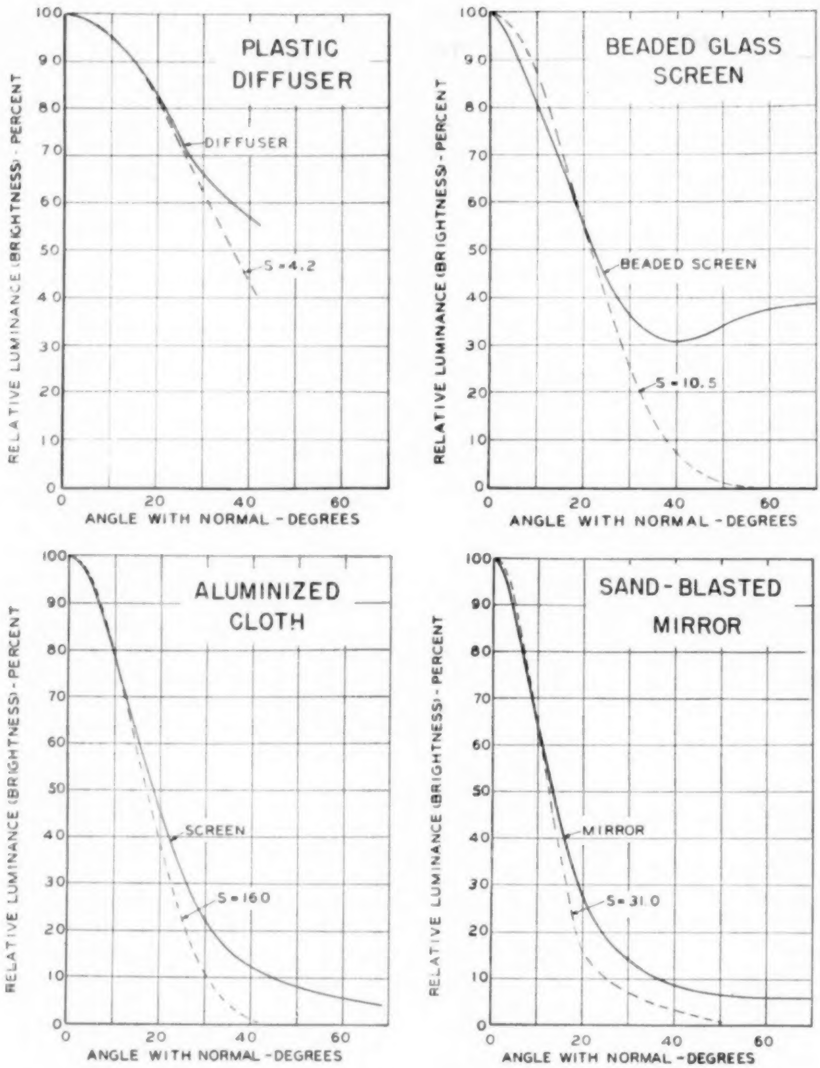

Fig. 2. Approximations of luminance fall-off for typical reflecting screens. Use of solid and dashed lines is the same as for Fig. 1; parts a-d, in the usual order

The *illuminance* or flux received per unit area at a point not on the screen illuminated by a circular area of the screen whose center is at the foot of the perpendicular from the point and whose radius subtends an angle α at the point is found by integration to be:

Lambert Surface

$$E_L = \pi B_L \sin^2 \alpha$$

Directional Diffuser

$$E_D = \frac{2\pi}{s+1} B_D (1 - \cos^{s+1} \alpha)$$

and the *luminous emittance* or total flux emitted by a unit area of the screen surface is:

Lambert Surface	*Directional Diffuser*
$L = \pi B_L$	$L = \frac{2\pi}{s+1} B_D$

If we neglect any differences which may exist in absorption or other screen losses, we can compare maximum normal brightness by assuming that the total luminous emittances are equal, in which case we see that

$$B_D = \frac{s+1}{2} B_L$$

This shows clearly why the "brightness" of a directional screen in footlamberts may often be several times the intensity of the incident radiation in foot-candles.

The "shape factor," s, provides a convenient index to the diffusing characteristics of the screen. For a perfect diffuser, it is of course, unity, while for a nondiffuser (free transmission or specular reflection) it becomes infinite. As shown by the curves in Figs. 1 and 2 it usually takes on values between 1 and 50.

These equations show why meters which actually read illuminance instead of luminance, do not give correct luminance readings for directional screens. For example, a meter such as the G.E. screen-brightness meter, having an admittance half-angle of 15° will read about 8.5% low, while for a screen having s = 10 this will drop to 20.5% below what it should read.

These equations have been found to be useful in predicting size and relative intensities of "hot spots" from data obtained from relatively small screen samples, in correcting transmission data taken by the various methods in current use, and in suggesting designs for suitable instruments for use in measuring various screen characteristics. They should also prove useful in the analysis of screen brightness data. Dr. Meyer[3] has found that some types of translucent screens apparently have s-factors which are dependent upon wavelength. Therefore, these equations may prove helpful in specifying tolerances for screens suitable for work with color photography. In any case, they extend the simplicity of mathematical treatment now applicable to Lambert diffusers to many important types of directional diffusing surfaces, and as such should be of interest and use in the motion-picture and television industries.

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[3] Private communication from Herbert Meyer of the Motion Picture Research Council.

Photography of Motion

By JOHN H. WADDELL

The use of photography for determining velocities, accelerations and degrees of movement in high-speed phenomena as well as in growing plant and animal life is discussed. Focal length of lens, distance from camera to subject, size of subject, corrective angles and magnifications of results are shown to be vital factors in every variety of time-motion study, and recommendations for achieving optimal results are made.

Precise means of measuring moving objects is becoming an increasingly important phase of photography. There is a wide interest in studies of motion. Subjects range from growing plants and bodies to artillery shells in flight, and even to the measurement of the velocity of light itself.

Photographs have been made of the human embryo from its conception, through birth, and eventually ending with the human body in death itself. It has been thus possible to measure rates of human growth over the complete life span, from the maximum of just before birth to the final, negative phase when the body becomes slightly smaller in old age.

Time-lapse pictures of the budding and blossoming of a flower are another interesting application of motion photography. In this case the exposure time will be short, but the frequency may be as low as once an hour to get a desired motion picture that can be used for visual observation and analysis.

A popular subject today for such studies is the rate of growth of the fireball of the atom bomb. A typical series of pictures made for this purpose is shown in "The Effects of Atomic Weapons" (Atomic Energy Commission, Washington, D.C., 1950). A picture frequency of about 8,000/sec was used in this instance.

In order that precise measurements of motion may be made, certain primary requirements, and the terms describing them, must be understood, as well as a technique of reading the resulting films.

In the determination of velocities, accelerations and the degree of movement from exposed film, the following must be known: (1) the focal length of the lens; (2) the distance from the camera to the subject; (3) the size of the subject; (4) corrective angles; and (5) the magnification of the reading or transcription system.

Presented on October 16, 1951, at the Society's Convention at Hollywood, by John H. Waddell, Industrial and Technical Photographic Div., Wollensak Optical Co., 850 Hudson Ave., Rochester 21, N.Y. (This paper was first received Nov. 24, 1952, and released July 21, 1953.)

Before entering any discussion of the photography of motion, an understanding of the meaning of velocity is imperative. Most observers think in terms of linear velocity only, in relationship to motion studies, but angular velocity is far more important photographically. One of the first questions to be asked is, "What is the angle of view or coverage of the lens?" This, indirectly, allows the photographer to calculate how far the subject will move during exposure and/or between exposures.

Linear velocity is equal to distance divided by time. Projectiles in flight are measured in feet or meters per second, motor cars in miles per hour, and boats by knots, while plants and animals may be measured in inches per day, week or month. It is possible to photograph these assorted space-time relationships and to show them in the same space-time relationship. The techniques for photographing the various subjects however, must of necessity differ.

Angular velocity technically is the quotient of angle divided by time. More simply, it is the distance the subject will move during the time of exposure in a given field size.

If a projectile is moving at a linear velocity of 1000 fps and if the field size is 1 ft, the projectile will move 1 ft during an exposure time of 0.001 sec, or $\frac{1}{10}$-ft in 0.0001 sec. In 1 μsec. it will move but 0.001 ft, or 0.012 in. If the field size is increased to 100 ft, the image size with the same focal lens is about $\frac{1}{100}$ what it was in the first case. The subject will travel as far as each exposure time given above, but the apparent image on the film is sharper because of its reduced size.

With a picture-taking rate of 1000/sec, one picture would be secured with a 1-ft field. With the 100-ft field, 100 pictures would be obtained.

In the instruction book issued for the Kodak High-Speed Camera, a formula is given for the determination of desirable camera speed (C.S.) for sharp pictures:

$$\text{C.S.} = \frac{40 \times \text{Speed of subject in ips}}{\text{Total width of subject field in in.}}$$

In order to see how this works practically in ballistics:
Projectile speed, 2000 fps or 24,000 ips;
Total width of field, 10 ft or 120 in.;

$$\begin{aligned}\text{C.S.} &= \frac{40 \times 24{,}000}{120} \\ &= 8{,}000 \text{ pictures/sec}\end{aligned}$$

In the 0.005 sec, 40 pictures will be obtained. If the pictures are taken at 14,000/sec, about 72 pictures will be obtained, requiring about 5 sec projection time.

If the field were 1-ft, 80,000 pictures/sec would be required, while with the 1000-foot field 800 pictures/sec would be adequate.

The above formula does not give the movement of the subject image on the film during exposure. However, with the 10-ft field and with an 8mm camera taking double-width pictures, the film width is 0.4 in. Therefore, the reduction is:

$$\frac{\text{(Field width) 120 in.}}{\text{(Film width) 0.4 in.}} = 300 \text{ times}$$

Table I gives the distance from the camera to the subject and the available lenses to secure this field width.

Table I

Focal length of lens	Distance, camera to subject		
1 in.	301	in.	(25.08 ft)
35 mm	421.4	in.	(35.12 ft)
2 in.	602	in.	(50.16 ft)
$2\frac{1}{2}$ in.	752.5	in.	(62.71 ft)
3 in.	903	in.	(75.24 ft)
4 in.	1204	in.	(100.33 ft)
6 in.	1806	in.	(150.50 ft)
10 in.	3010	in.	(250.8 ft)
15 in.	4515	in.	(376.25 ft)

It is to be observed that from each of these camera positions, the field size will be the same. And from the com-

parative standpoint, the depth of field can be the same.

With this reduction in size, and with a velocity of 2000 fps, 4 pictures will be made per foot of travel of the projectile. Therefore, the subject will travel during exposure:

$$2000 \times \frac{1}{8000} \times \frac{1}{6} = 0.0417 \text{ ft or } 0.5 \text{ in.}$$

Fps × Reciprocal of Picture-Taking Rate × Exposure Cycle Rate = Movement of Subject

Based on the 300 times reduction, the image on the film will move during exposure 1/300 of 0.5 in. or 0.00167 in., which is excellent for frame-by-frame analysis.

To go to the other end of the scale to secure the opening of the flower or the growth of a plant, the same type of calculation is required. If a flower takes 4 days to open completely and a 15-sec end sequence is required:

$$15 \text{ sec} \times 24 \text{ pictures/sec} = 360 \text{ pictures}$$

$$4 \text{ days} = 5760 \text{ min}$$

$$\frac{5760}{360} = 16, \text{ or 1 picture every 16 min}$$

One is able to control the exposure of time-lapse photography far more easily than the exposure in high-speed photography.

A man hitting a golf ball, photographed with a 10-ft field, makes an excellent subject at 1000 pictures/sec, while the impact of the club on the ball in a 4-in. field cannot be satisfactorily photographed at 14,000 pictures/sec.

(1) Focal Length of Lens

The focal length of the lens is nominally the distance from the lens to the film plane when the lens is focused at infinity. There is one school of thought which believes that the effective focal length for measurement purposes should be based on the hyperfocal distance rather than the infinity focus.

The comparative change in effective focal length (infinity focus) is given in Table II.

Table II

Nominal effective focal length, in.	Maximum aperture of lenses calculated (f-stop)	Hyperfocal distance at maximum aperture,* ft	Correction to be added to effective focal length, in.
1	2.5	33.3	.00118
35mm	2.0	79.1	.00200
2	2.0	166.7	.00200
2½	2.7	192.9	.00271
3	2.5	300	.00250
4	3.5	380.95	.00351
6	4.5	666.7	.00451
10	4.5	1851.9	.00450
15	5.6	3348	.00560

* With the lens focused on the hyperfocal distance, all objects from half the hyperfocal distance to infinity are in focus. The calculation for hyperfocal distance is based on:

$$H = \frac{f/2}{f/\text{number } x}$$

The circle of confusion is assumed to be 0.001 in.

The ASA standards on lens focal length allow a ±4% deviation from nominal or marked focal length. All lenses to be used for measurement purposes, therefore, should be marked in the EF to the nearest tenth-millimeter or thousandth of an inch.

It is to be pointed out that the focal length will also be a contributing factor in the angular field coverage. The expression "angular coverage" in this paper refers to either vertical or horizontal only, and not to diagonal. Most engineers follow the line of action in either the vertical or horizontal planes in measurement.

$$\tan \tfrac{1}{2} x = \frac{\tfrac{1}{2} \text{ Frame width}}{\text{Focal length}}$$

It can easily be seen that the 4% variation will have a serious effect on angular coverage — and this becomes more critical with longer focal length.

Table III

	Temperature Fahrenheit			
	−65°	0°	70°	150°
Aluminum	−.00186	−.00097	.0000	+.00111
Brass	−.00134	−.00070	.0000	+.00080
Invar	−.000067	−.000035	.0000	+.000040

(2) Distance From Camera to Subject

The distance from the camera to the subject is one of the most confusing points in measurement and designation of focusing scales. ASA has established a standard marking on the camera, "Film Plane" being designated by a circle with a vertical line passing through it. It must be realized, however, that the term "Film Plane" may not mean much to an average user, and this has been modified on Fastax cameras to read "Measure subject distance from here," with the same bisected circle designation. The allowable deviation is then ±2 line widths from the nominal marking on the lens.

Furthermore, on the focusing scale there should be an over-run beyond the infinity marking. Most camera operators do not feel satisfied unless they can go beyond infinity and then come back to infinity when they are focusing.

No reliance should be placed on focusing scales in extreme limits of temperature, the effects of extreme heat or cold becoming more noticeable with longer focal-length lenses. The aerial image should be the standard of focusing under these conditions.

Table III illustrates the change in lens-tube length per unit length for temperature ranges specified by the military forces and those actually occurring in the United States.

It is obvious that if a 10-in. lens tube is used, the back focus will be pushed .019 in. behind the normal film plane with an aluminum tube at −65 F while it will be pulled 0.011 in. ahead of the film plane at +150 F. The above does not take into consideration what takes place in the lens cells themselves. They should be constructed with invar separators.

Besides the focusing scale on lenses for measurement, there should be a temperature-compensating scale. This is doubly imperative because lenses in high-speed photography are in many cases used "wide open." It is also imperative that the materials used for lenses have a minimum coefficient of expansion — and that they should not have a black external finish.

Many high-speed photographers are using infrared filters to accentuate the sky, particularly in missile work. This changes the back focus. The rule for photographing in the near infrared is to increase the back focus 1/88 the normal focal length. There is no effect on the back focus with visible light.

There is another disturbing factor in measurement that is frequently overlooked. It is that of atmospheric convection currents. Most survey work on the desert is done from midnight until sunrise. The currents or "jitter" have a very disturbing effect on camera focus and on the photographic results obtained. Pictures taken with Askania cameras and standard-speed motion-picture cameras at elevations of less than 20° are unique in many respects, but practically useless for a precision measurement. This effect is minimized by elevation and altitude and by shortening of exposure time. High-speed motion pictures are practically free from this effect. The greater the distance from object to the camera, the more "atmospheric jitter" will be present.

(3) Size of Subject

The size of the subject can be used for computation of velocities and field size. The magnification is

$$M = \frac{D - F}{F}, \text{ where}$$

D = distance of object to film plane
F = focal length

The above formula is approximate. A deviation of the exact formula gives the following relationships:

$$M = \frac{X}{F} = \frac{F'}{X'}$$

Reduction is the inverse ratio from the magnification factors given above.

(4) Corrective Angles

The angle of the motion to the camera is important from a number of points of view.

The amateur cinematographer usually learns the hard way that a child on a swing gives the best stroboscopic effect when the camera is 90° to the direction of the swing. It becomes less at 45° and an even picture is obtained head-on. "Panoraming" makes an audience dizzy. But as the camera is focused on a moving subject and follows it, the subject is sharp. This is a practice followed by press photographers and newsreel cameramen.

There are two major types of angular problems which are typical of field installations: that in which the distance to the center of the field is known; and that in which the distance is known to the point where the subject will enter the field. Trigonometry solves these problems as follows:

$$\frac{a}{\sin A} = \frac{b}{\sin B} = \frac{c}{\sin C}$$

In Fig. 1, the case where the distance to the center of the field is known, this triangle requires the solution of two triangles in the following steps:

$A = 30°$ angle of view
$A' = A'' = 15°$
$B = 95°$
$C = 55°$
$D = 20°$ angle of flight
$b' = 100$ distance of center of field
$a' + a'' =$ a path of the subject

In triangle I

$$\frac{a'}{\sin A'} = \frac{d}{\sin B}$$

In triangle II

$$\frac{a''}{\sin A''} = \frac{d}{\sin C}$$

Solving

$$\frac{a'}{\sin 15°} = \frac{100}{\sin 95°}$$

$$a' = 26 \text{ ft}$$

and

$$\frac{a''}{\sin 15°} = \frac{100}{\sin 55°}$$

$$a'' = 31.5 \text{ ft}$$

Therefore

$$a' + a'' = 57.5 \text{ ft}$$

And now, the second problem, as shown in Fig. 2:

$A = 30°$ angle of view
$A' = A'' = 15°$
$B = 95°$
$C = 55°$
$D = 20°$
$d = 100$

$$\cos A'' = \frac{d}{c}$$

$$\cos 15° = \frac{100}{c}$$

$$c = \frac{100}{.966} = 103.5 \text{ ft}$$

$$a = \frac{c \sin A}{\sin c}$$

$$= \frac{103.5 \times \sin 30°}{\sin 55°}$$

$$= 63 \text{ ft}$$

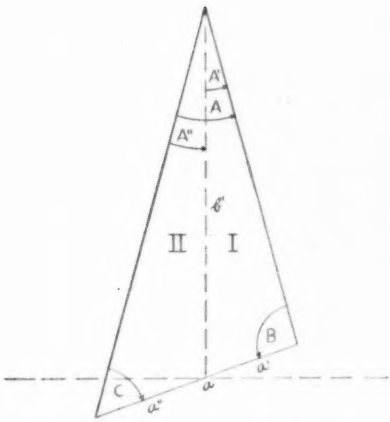

Fig. 1. Flight path where subject bisects known distance from camera.

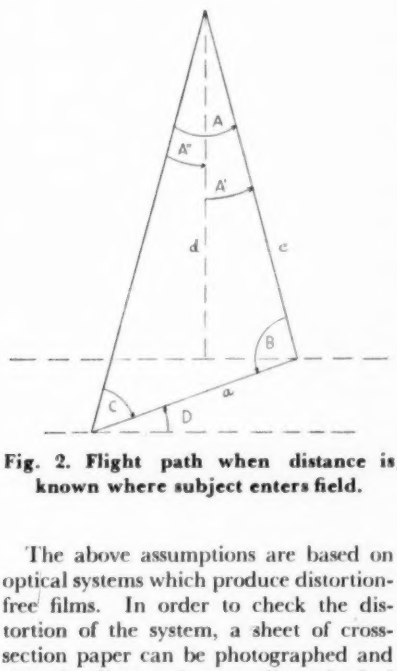

Fig. 2. Flight path when distance is known where subject enters field.

The above assumptions are based on optical systems which produce distortion-free films. In order to check the distortion of the system, a sheet of cross-section paper can be photographed and then the distance between lines checked with a microscope over the whole field. The objectives for measurement selected must be good ones however.

(5) The Reading System

In the reading of the film, the projection optics should be equal in resolution and field flatness to the exposing optics. In order to cut costs of manufacture, inferior optics are often used, as is sometimes apparent in slide and motion-picture projectors. The projection lens on the time-and-motion study projector should be a photographic objective, because many users project their films frame by frame, particularly those taken with high-speed motion-picture cameras. The focal length of the lenses should be accurately marked, so that the user can make good measurements.

In many microfilm readers, the same condition exists. It is becoming imperative that the magnification factors be calibrated for the study of motion. The finest of cameras will be wasted if the resultant film is studied through poor reproduction optics.

One manufacturer provides a test film taken with the camera when ready for delivery. The film consists of a National Bureau of Standards Resolution Test Chart as photographed with that particular camera. The test chart shows resolving power up to 56 lines/mm. It has been demonstrated many times that the best resolution that can be shown on some types of optical comparators and ground-glass screen projectors is a resolving power of one-half or less than that obtained through a straight optical system. A resolution of 56 lines/mm is approaching the limit of many high-speed panchromatic emulsions.

Milk-bottle glass lenses are a cheap, time-wasting and worthless means of examining fine, accurately made films.

Exposure time should be critically examined. Theoretically, exposure should be based on a square-top wave. The exposing device should open *instantaneously*, remain open for the desired time and then close *instantaneously*. No devices yet available follow this pattern.

High-speed gas-discharge tubes have a decay time, focal-plane shutters move across the film, barrel shutters and rotating prisms follow a sine wave, mechanical shutters have both opening and closing time. The fastest-operating shutters are the piezo-electric or electro-optical shutters, which operate off a single pulse such as a radar pulse.

An interesting question was raised by one high-speed photographic user. He was using a spark for schlieren photography. The photographs showed that the schlieren picture exposure was 1 μsec. A calibration was desired, and a streak picture of the spark discharge was therefore made. It was found that the discharge required 100 μsec to take place, but that the actinic photographic exposure took place in only 1 μsec.

In the Fastax camera, the approximate exposure time is given at $\frac{1}{6}$ times the reciprocal of the picture-taking rate. At 1000 pictures/sec, the exposure time is 0.17 msec; at 15,000 pictures/sec, 12 μsec. With the Edgerton flash unit designed for the Kodak and Fastax cameras, the exposure time is $1\frac{1}{2}$ μsec. With the rotating prism, the image sweeps with the film and a highly resolved image is obtained. If the flash unit is used without the prism, the image is smeared by the following amounts:

Film velocity, fps	*Image movement during exposure, in.*
$1\frac{1}{2}$-μsec flash	
5	0.00009
50	0.0009
100	0.0018
200	0.0036
1000	0.018
20-μsec flash	
5	0.0012
50	0.012
100	0.024
200	0.048
1000	0.240

Therefore, if a limit of 0.00025 in. is placed as the upper tolerable limit of image smear, the data are given below to show the time of exposure and maximum velocity to produce this limit.

Exposure, sec	*Film velocity, ips*
0.000001	250.0
0.00001	25.0
0.0001	2.5
0.001	0.25
0.01	0.025
0.1	0.0025
1.0	0.00025

It can easily be seen that for film velocities of more than 20 fps, image compensation is useful.

With focal-plane shutter, 1/1,000 in. is the lower useful limit at present; with the compound shutter 1/800 in. is the lower limit while other shutters fall in this grouping. The electric spark has a low limit of about $\frac{1}{10}$ μsec, while the piezo-electric effect can be operated at 1/1,000 μsec.

Back in 1880 Muybridge used multiple cameras to get the trotting horse pictures. Multiple cameras are used today to secure time resolution to a high degree, but they cover the same field of view.

In such an arrangement, all the cameras must be receiving the same time signal to drive the gas-discharge (neon) timing light or the spark. Each light must begin to function some time after the cameras have started, so that zero time is established on all films. With rotating-prism cameras driven by series motors, the prisms are all in random positions. It is possible to secure measurements to an accuracy of 1 μsec by using 14 cameras at 16,000 pictures/sec and assuming the exposure time of 10 μsec per picture.

By reading the leading edge of the motion, and with milli-second timing marks establishing the angle of prism rotation with respect to the next camera, the readings from 14 films will give the microsecond accuracy.

A formula for the establishment of

number of cameras with random shutter positions, constant exposure times, and other factors, is given in a paper by Wilkinson and Romig.*

The use of 10 or 20 less expensive cameras with high resolution will often produce space-time resolution over a *much longer* period of time than will a single ultra-high-speed camera with fair resolution or with limited picture-taking capacity.

Another extremely valuable aid in the photography of motion is the use of stereoscopy. The perception of depth achieved through the two eyes of human vision assists materially in the analysis of space motion. In some cases, people born with one eye learn to visualize this differentiation of space, but it is, of course, far more readily observed with the use of two eyes. Stereoscopy, with an interpupillary distance of approximately $2\frac{1}{2}$ inches can be practiced up to distances of 1000 to 2500 ft. Greater distance perception can be obtained by artificially increasing the interpupillary distance to a base of from 6 in. to 20 ft or more. Where the broad base is used, however, there should be nothing in the foreground.

A number of devices have been used in stereoscopic photography. The most common are twin-lens cameras with the $2\frac{1}{2}$-in. interpupillary distance; single-lens cameras with mirror or prism beam splitters (this includes the use of wedge prisms); beam splitters with individual lenses; single cameras and single lenses moved through a known interpupillary distance (this latter method is used in aerial photography). There are advantages and disadvantages to each of the above methods. In order to broaden the base of high-speed motion picture photography, there have been stereoscopic devices designed to assist in the analysis of motion.

As a further aid in the study of motion, reticles and fiducial marks are used to help establish the base lines for measurement. In the case of intermittent and still photography, the aperture plate may be notched, or crosshairs may be placed in the plane of the image. In the case of high-speed motion-picture cameras, there has been designed a system which consists of moving the objective lens ahead of the point at which it would normally be used. The image from the objective lens is laid down on a collecting lens which has a reticle engraved upon it. A one-to-one relay lens system then lays the image down at the film plane. Because the image is in a reverse position, compared with the normal photographic procedure, projecting the films is accomplished by putting a roof prism in front of the projection lens to get the picture back into normal orientation.

The measurement of the film for motion remains to be discussed. Projectors are normally used for measuring purposes in the case of motion-picture film. The projector will, of course, have a certain amount of natural jump, and therefore measurement by this means should be confined to qualitative factors only.

Frame-by-frame analysis of the individual pictures is far more important. This is aided by fiducial marks, often on the original film. Today most projectors of this type back-project the film onto a ground-glass screen. Where the subject is small, however, the grain structure of the screen may interfere seriously with the ability to measure the film. As was mentioned above, the object may actually move during exposure, and, therefore, it becomes quite difficult to establish a point of measurement. The ordinary procedure in such a case is to measure the leading edge of the smear. Where wide-angle lenses are used, or where there is no change in

* Roger Wilkinson and Harry Romig, "Space-time relationships with multiple-camera installations," presented on October 8, 1952, at the Society's Convention at Washington, D.C. Early publication in the *Journal* is planned.

the magnification of the projection system, templates can be designed and used to cover the necessary distance or angular calibrations.

The ideal system would be to take films which have fiducial marks (used with intermittent cameras) or projected reticles (used with continuous cameras) and project the image at 10 × magnification onto a clear-glass screen. Use a mark (engraved) on the clear screen for focusing the eyepiece, and fiducial or reticle marks for the superimposition of the projected film image. A 5 × eyepiece on a pantograph arrangement may then be used to measure the position of the test object on the film. The pantograph is so arranged that the $\pm x$ and y values from the center may be noted on a counter. Alternatively, a prepared linear scale may be engraved on a clear-glass screen at any desired footage or angular base.

If the camera is reducing the original subject 100× and the projector is working at 50× magnification, it is apparent that the subject is one-half normal size, an easily measured image. Even if there is motion in the subject, the "fuzzy" leading edge will still be a good point to measure from picture to picture. The picture or subject does not have to be frozen for accurate readings.

Another instrument valuable for measurement of motion is the densitometer. This instrument is used for brightness or intensity measurements. It is possible to make very good measurements with the frame-by-frame or streak cameras by correlating time and density measurements from any part of the film. Flames, explosions, and detonations are typical subjects for these studies.

This technique is not valid for reversal film, but only for negative. In a reversal film, with a controlled second exposure, the processing will alter the desired result.

H&D strips are placed on the negative or on a strip of negative material of the same emulsion number as the test film. A test negative is made of a subject of known brightness such as the sun. It may be necessary to reduce the intensity with neutral-density filters in order to place it on the midpoint (such as a density of 1.2) of the straight-line portion of the H&D curve. A plot is then made of time of exposure (preferably to the millisecond) and obtained density. That is the starting point even with density-correcting filters. For more intense incandescent points, heavier filters are used; for subjects of moderate brightness, more transparent filters, or none at all, may be employed. Three color-separation negatives may be made this way, and individual color prints made from any point on the film, providing zero time marks start after the film has started, and the same oscillator is used for timing purposes. By using sharper-cut color filters, measurements can be made in any portion of the spectrum from the near-ultraviolet to the infrared for the broad-band spectral analysis of flame components.

The reading of films for measurement of motion is oftentimes quite laborious, but it pays dividends from the standpoint of accuracy.

In conclusion, then, it may be said that the photography of motion is a fairly simple proposition if one takes into consideration the space-time relationship, the rate of growth, angular velocities, and endeavors at every step to ensure accurate measurements.

The BRL-NGF Cinetheodolite

By SIDNEY M. LIPTON and KENNARD R. SAFFER

A number of incomplete Askania cinetheodolites are being extensively rehabilitated and modified under a joint program of the Navy Bureau of Ordnance and the Army Ordnance Ballistic Research Laboratories. New features include improved bearings, data circles, complete replacement of all mount components except carriage castings, a Mitchell high-speed camera movement operating synchronously at 16, 32 or 64 frames/sec, 500-ft magazines, and telescopic optical systems of 60-, 96-, 144- and 180-in. focal lengths.

THROUGH a joint program of the Ballistic Research Laboratories of the Army Ordnance Department, and the Naval Gun Factory under the direction of the Navy Bureau of Ordnance, the modification of a group of existing incomplete Askania cinetheodolites has resulted in a new, improved and radically modified cinetheodolite. At the present time these new instruments are in the process of construction and the first prototype model is nearing completion.

Many of the features planned for this instrument have previously been tried out in other instruments but several proposed features have yet to be actually field tested.

The improved accuracies of bearings and circles have already been demonstrated in similar cinetheodolites furnished to the U.S. Naval Ordnance Test Station, Inyokern, Calif. Long focal-length telescopic systems, and high variable-speed cameras with large film capacity have been used at White Sands Proving Ground, Las Cruces, N.M., in similar cinetheodolites. The use of a synchronously operated multispeed camera, a range of quickly changeable long focal lengths, and the use of the particular type of target-acquisition system employed here have not yet been field tested. The configuration of the camera drum, the incorporation of a standard high-speed Mitchell movement, the provision for phasing in the shutter operation with a central signal, the arrangement of the 500-ft magazines, the provision for a quick field check of infinity focus and collimation and the use of standard-frequency power for the motor drive are new as far as the WSPG range cinetheodolite instrumentation is concerned.

This instrument is planned for use at the White Sands Range for both Army and Navy projects and the design fea-

Presented on May 1, 1953, at the Society's Convention at Los Angeles by Sidney M. Lipton (who read the paper), Bendix Radio Communications Div., Bendix Aviation Corp., Baltimore, Md. (formerly of Ballistic Research Laboratories, Aberdeen Proving Ground, Md.), and Kennard R. Saffer, U.S. Naval Gun Factory, Washington, D.C.
(This paper was received on May 4, 1953.)

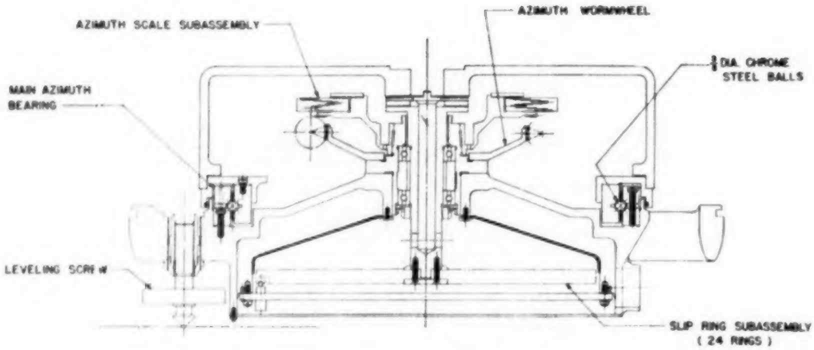

Fig. 1. Mounting-base assembly.

tures of this cinetheodolite have reflected the particular requirements of this range.

It was found that the existing German design of the main azimuth bearing and the elevation trunnion bearings were not suitable for photographing fast moving objects. Specifications were set forth by ordnance test stations requiring a theodolite to train in azimuth about its vertical axis within a tolerance of plus or minus five seconds of arc. Likewise the same tolerance was specified for the rotation of the camera drum about the horizontal axis. The glass scales used for recording angles of azimuth and elevation were required to be engraved to an accuracy of two seconds of arc.

It was also evident that the picture rate of the German Askania camera of 4 frames/sec was insufficient. Likewise, the German 30.0- and 60.0-cm focal-length photographic-objective lenses were not capable of photographing targets at long range.

Previously designed azimuth bearings for this instrument, which were successfully used at the U.S. Naval Ordnance Test Station, were found to meet these required tolerances. The cross-sectional area of the bearing for this instrument was increased for ease of manufacture.

Figure 1 shows a cross-section view of the main azimuth bearing and the center spindle assembly.

(a) The azimuth bearing consists of an inner and outer race. The outer race is divided into two parts separated by a spacer which is ground to the proper thickness to eliminate any shake between the balls and the race.

(b) The center-spindle assembly is fitted to the base. The vertical axis of the instrument is established by the rotation of the spindle on precision ball bearings. These bearings have an ABEC-7 rating. From this axis the outside diameter of the main azimuth bearing seat is machined concentric within 0.0002 in.

(c) After the bearing is assembled and the top and bottom surfaces of the complete bearing are checked for parallelism, it is then placed in the base. The bearing seat on the base is scraped so that the outer race can be properly seated and secured without introducing any rotational error. The inner race is seated to the rotatable carriage in a like manner and then secured. The rotational force is transmitted from the base to the carriage through 68 $\frac{3}{8}$-in. diameter chrome steel balls.

(d) The azimuth scale mount is then fitted to the center-spindle housing on a tapered surface. With the glass scale loosely placed in its mount, the assembly is rotated about the tapered fit. By means of eight concentric marks on the glass scale, a concentricity check is made

on each mark viewed through a 100-power microscope. After the scale is adjusted truly concentric with the vertical axis of the instrument, the scale retainer is secured and the glass scale cemented in place. By this method of assembly the concentricity error between the glass scale and the main azimuth bearing is held to an absolute minimum. The rotatable carriage is mounted to the inner race of the main azimuth bearing by a close pilot fit which is machined concentric to the rotation of the azimuth bearing. A coupling arrangement is provided for the mounting of the carriage to the center spindle to offset possible binding between the carriage, which finds its center about the main azimuth bearing, and the vertical axis of the base.

(e) Twenty-four slip rings are provided to allow for continuous rotation in azimuth. The brush-holder mount is designed so that the replacement of brushes would be relatively simple. Metal brushes are used to keep the voltage drop to a minimum. Electrical connectors are provided on the underside of the base to supply power for the operation of the camera and other electrical units.

(f) The carriage assembly trains in azimuth about the vertical axis by means of a worm-and-gear drive operated by a handwheel. The handwheel subassembly provides a two-speed gear ratio, namely, 1° rotation of the instrument per one turn of the handwheel in slow speed and 4° per turn in high speed. To change from one ratio to another, the handwheel is either pulled or pushed in an axial direction.

(g) The azimuth and elevation internal glass scales are made of plate glass to Bureau of Ordnance specifications. They are engraved every one-half degree to within an accuracy of two seconds of arc.

The azimuth scale mount can be rotated by means of a spring-loaded clutch enabling the operator to align the zero point on the scale to any desired position.

Figure 2 is a cross-section view of the assembled carriage and slip-ring assembly.

(a) Microscopes of 30-power are provided on the azimuth and elevation sides of the instrument. When the positioning lever is depressed, the microscope is inserted into the optical path of the scale-projection system. This enables the operator to read the internal scales directly in degrees and minutes. A spring tension on the positioning lever requires the operator to hold the microscope in a reading position. As soon as pressure is released from the lever the microscope is retracted from the optical path of the scale-projection system. This feature assures an uninterrupted projection of the scale readings to the film plane when the camera is in operation. The azimuth and elevation angles are simultaneously photographed with the target. The internal scales are illuminated by flashlamp units which are synchronized with the camera shutter so as to allow proper illumination for projecting the scale readings to the film plane. The advantage of photographically recording the azimuth and elevation angles with the target is that recording errors due to rate of change in tracking error are eliminated. This method provides accurate data for determining and recording the trajectory of the target.

(b) The camera drum rotates in precision ball bearings about the horizontal axis by means of a worm-and-gear drive operated by a handwheel. The handwheel subassembly is provided with the same gear ratios as those in the azimuth drive. The ball bearings used for the rotation of the camera drum about the horizontal axis have an ABEC-9 rating.

(c) The camera-drum trunnions are machined concentric to the horizontal axis. After the drum is assembled in the trunnion bearings on the carriage, the horizontal axis is checked for parallelism to the rotation of the main azimuth bearing. The elevation glass scale is then mounted on its housing. By means

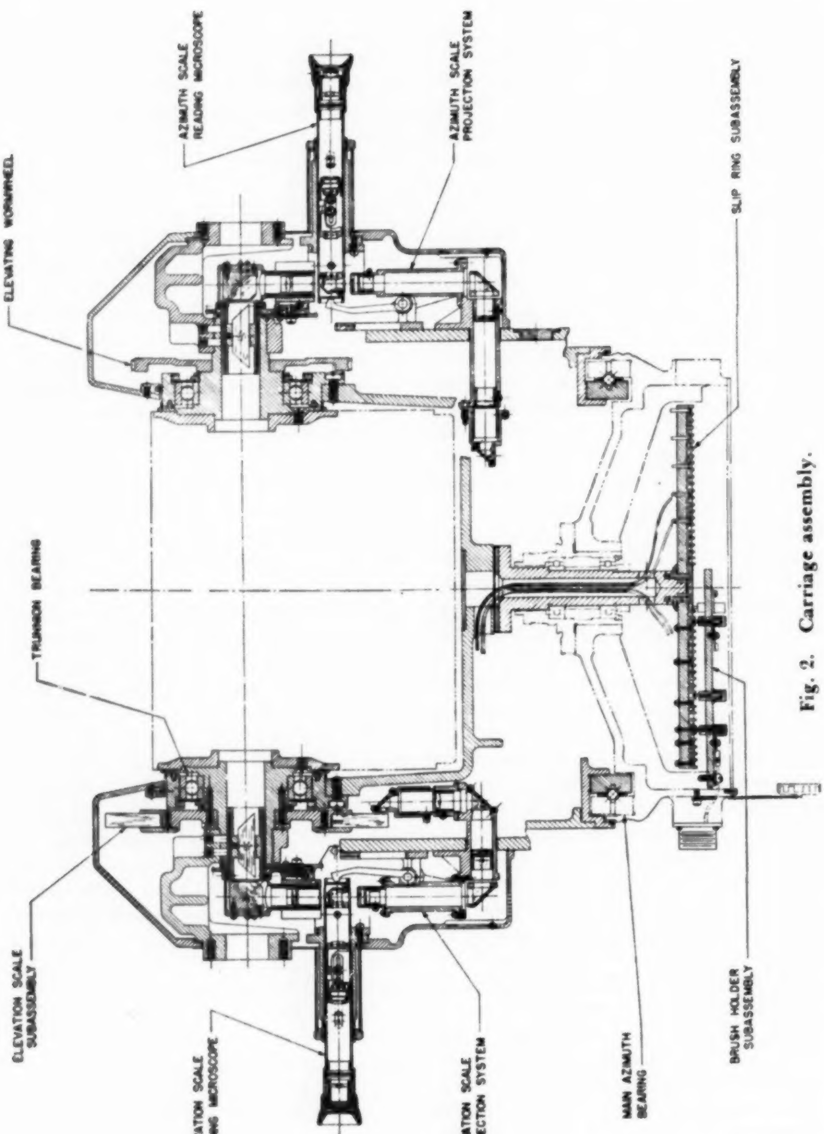

Fig. 2. Carriage assembly.

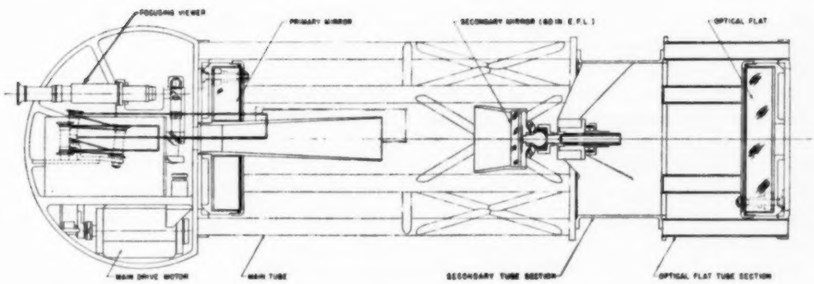

Fig. 3. Side elevation of camera and main optical system (60-in. E.F.L.) with focusing attachment.

of eight concentric marks on the glass scale, it is centered about the horizontal axis. The scale retainer is then secured and the scale is cemented in place.

(d) The guiding telescope is a monocular right-angle type with interchangeable eyepieces to provide for magnification of 12- and 20-power. The eyepieces can be focused from -2 to $+4$ diopters. The two eyepieces can be interchanged by pulling one of the complete assemblies from the body of the telescope. By means of a piloting fit and a positioning dowel, the other eyepiece assembly can be inserted into the telescope body. It is held in place by three spring-loaded detents and is secured by a lock screw.

Crossline illumination is provided for the reticle. The light intensity can be varied by a rheostat for sighting under adverse light conditions.

The complete telescope weighs 7 lb and has a moment of 42 in-lb about the horizontal axis. The telescope mounting bracket is counterbalanced to offset this moment.

The optical characteristics of the telescope are as follows:

	Low Power	*High Power*
Magnification	12×	20×
True field	5°	2° 45′
Eye distance	24.5 mm	15.0 mm
Exit pupil	5.0	3.0 mm

When the field location of these instruments is a considerable distance from the starting point, the target will not be visible initially to the tracker due to differences in elevation, atmospheric conditions or reduction in size of image caused by long horizontal lines of sight.

To enable the tracker to follow the target even though not visible, a remote-indication system will be set up in the field to transmit to these instruments electrical signals which will be a function of the relative position of the target.

The reception of such signals at the instrument will result in a galvanometer-pointer deflection, visible to the tracker. By tracking the instrument properly, each tracker will tend to keep this pointer deflection at the zero mark. This will mean that the target is in his field of view. By occasionally checking in the guiding telescope, the tracker will eventually sight the target and continue tracking thereafter visually.

The main optical system, shown in Figs. 3, 4 and 5, consists of a Cassegrainian telescope. There are four focal lengths available: 60, 96, 144 and 180 in. Figure 3 shows the layout for the 60-in. system. The clear aperture of the main mirror is $7\frac{15}{16}$ in. and its focal length is 24 in. The main mirror is held in an adjustable cell mount in which tilting of the mirror is possible so that it may be aligned correctly with reference to the

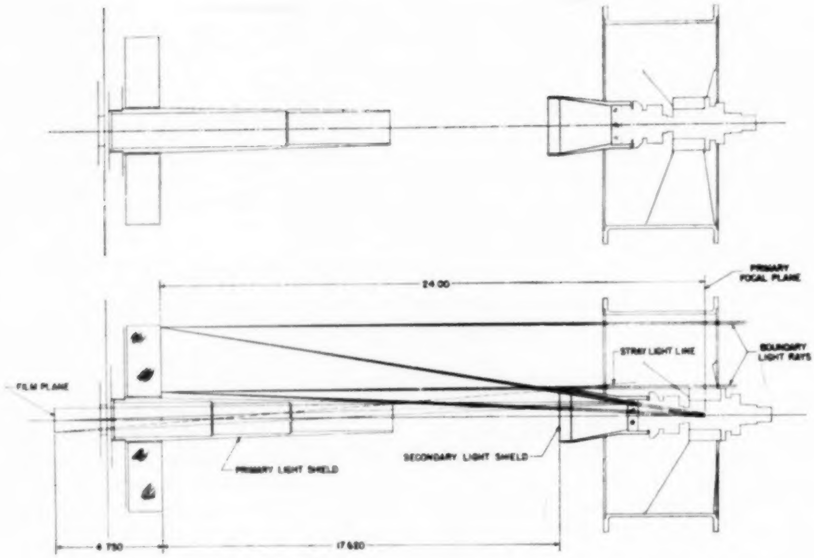

Fig. 4. Optical diagram for (above) 144-in. and (below) 180-in. E.F.L. system.

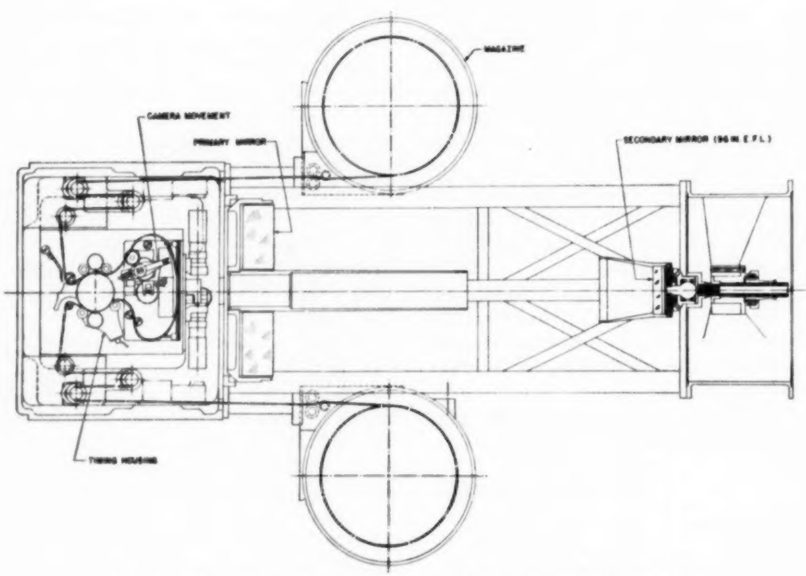

Fig. 5. Plan view of camera and optical system (96-in. E.F.L.).

film plane and the secondary mirror. The secondary mirrors are mounted in cells which are assembled in holders in which tilting and translation along the optical axis can be effected in small increments by means of setscrews, a ball-and-socket joint, bearing surfaces and fine threads. Movements along the axis may be controlled and repeated to 0.001 in. by means of a vernier screw. The final position of the mirror is then established by a locking nut. The secondary mirror assembly is fitted into a small central cylinder, web-supported, which is an integral part of an aluminum-alloy housing. This housing is a separate section of the main telescope tube which may quickly be removed and exchanged for another similar housing containing a different secondary mirror providing a different equivalent focal length for the main optical system. Once each secondary mirror has been adjusted and collimated with the main mirror, removing it with its housing and later replacing it, when necessary, should not change its previous position since locating rings and a key will re-position it to a few thousandths of an inch of its previous location; the locating rings are hard steel inserts which prevent translation, the key prevents rotation, and a mating steel butting surface maintains the correct distance from the main mirror.

This secondary aluminum-alloy housing is a casting designed to fit a particular secondary-mirror assembly; each instrument will have four different secondary-mirror and housing assemblies.

In the field, the instrument operator may determine the correct infinity focal-point setting of the secondary mirror by means of an autocollimating type arrangement which he can quickly assemble and disassemble. Figure 3 illustrates this apparatus, which consists of an optical flat, a mirror, reticle and prism arrangement, a 2-w zirconium-arc source and a viewing microscope with a 40-mm objective.

An 8-in. optical flat in an adjustable cell-holder assembly is mounted on the end of the secondary housing. A bracket containing the microscope, mirror, reticle and prisms is inserted in the camera drum and locked into position. The zirconium-arc lamp is connected into position, so that its light is directed through the prisms and illuminates the reticle. The light goes through the main mirror system to the optical flat and then back again through the main mirror system where an image of the reticle is formed near the illuminated reticle pattern. After focusing the microscope on the illuminated reticle, the operator then translates the secondary along the optical axis until the image of the illuminated reticle is also in focus. For an object distance other than infinity, the secondary mirror is then moved an additional precalculated distance away from the main mirror. In this manner, the optical system may be checked each time before use, if, for example, temperature differences are such as to cause expansion or contraction of the structure between mirrors.

The main tube has an open latticework construction consisting of end flanges of aluminum alloy and connecting thin-wall steel tubing (0.032-in. wall). The deflection of this main tube, assembled with a secondary mirror housing in operating condition, has been measured and found to be 0.001 in. from vertical to horizontal position. This is a systematic error which may be corrected for in the final reduction of the film data.

Openings have been provided in the main tube, near the main mirror end, to allow for removing the mirror cell and also for inserting the main mirror cover.

The entire main optical-system assembly, without the magazines attached, weighs 32 lb and exerts a moment about the trunnion centerline of 240 in-lb. With magazines loaded (total of 500 ft of film), these quantities become 40 lb and 360 in-lb.

Counterbalancing of this system is effected by the camera-drum housing

Table I. Main Optical System Characteristics.

Effective focal length, in.	60	96	144	180
Amplification	2.5	4.0	6.0	7.5
Distance between primary and secondary, in.	15.786	18.250	19.893	20.618
Area obstructing primary aperture, sq in.	13.30	9.18	6.66	5.47
Net primary area, sq in.	36.18	40.31	42.83	44.01
Secondary clear aperture, in.	3.00	2.10	1.51	1.24
Ratio of central obstruction diameter to primary diameter, %	51.9	43.1	36.7	33.3
Ratio of central obstruction area to primary area, %	26.9	18.5	13.5	11.1
Net focal ratio	8.84	13.41	19.51	24.06

Clear aperture of primary	7.9375	in.
Area of primary	49.5	sq in.
Focal length of primary	24.0	in.
Distance of film plane behind primary	4.75	in.
Diameter of image field at film plane	1.062	in.

design and by external counterweights. The semicylindrical shape of the camera drum and its point of suspension on the trunnion axis place most of its weight behind the trunnions. The camera-drum covers are of steel while the drum itself is aluminum alloy; these covers also help in counterbalancing.

Figure 4, showing the arrangement of the 144-in. and 180-in. focal-length systems, shows also a typical ray tracing. A light shield is used both at the main mirror and at the secondary mirror to prevent stray light from entering the system. These shields are designed to use as much light-collecting area of the main mirror as possible.

Table I, giving the main optical-system characteristics, shows the amount of light which is obstructed because of the secondary mirror cell, its supporting structure and the light shields for the different secondary mirrors. The effective focal ratios are 8.84, 13.41, 19.51 and 24.06.

Figure 5, with the 96-in. focal-length system, shows the film path and the camera layout. The size of the image field at the film frame is 0.7 in. square. The camera drum contains the camera mechanism, the motor and gear drive, a timing-lamp housing, a frame counter, a gaseous discharge tube (Edgerton lamp) and a lamp trigger pickup and amplifier.

The magazines are placed outside the drum, one on either side of the main tube, so that it is possible to plunge the instrument, or turn the main tube and drum through an elevation angle of 180°. Each magazine can hold 500 ft of 35mm film. Laboratory tests have indicated no appreciable increase in torque when the film roll is in a horizontal position in the magazine, when the film edge slides on the inner surface directly or rests on a thin aluminum disc which revolves with the film roll. The take-up magazine is equipped with a 1/40-hp universal motor which operates between approximately 600 and 1000 rpm; the connection between the motor shaft and magazine shaft is through a 1:3.5 pulley ratio using a Gilmer timing belt. This motor, when stalled under these conditions, does not heat up excessively.

The camera mechanism is a standard Mitchell high-speed 35mm movement. This has been left assembled in its housing which has been stripped down, eliminating such features as are not required in this application, such as rack-over inserts and doors. Additional com-

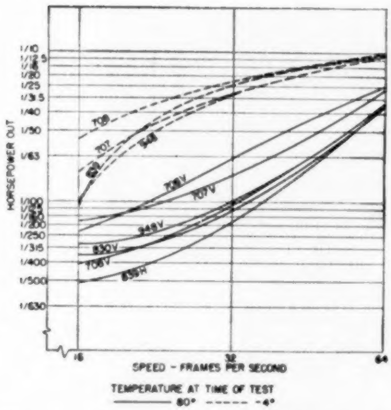

Fig. 6. Horsepower requirements for 35mm Mitchell high-speed movement at ambient and low temperatures.

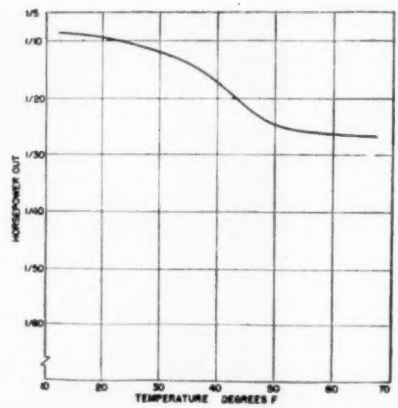

Fig. 7. Horsepower requirements for 35mm Mitchell high-speed movement operating at 32 frames/sec.

ponents have been eliminated or modified; the differential unit for shutter movement has been omitted; the shutter opening will be varied in 15° increments, while the movement is stationary, by means of a knob and a series of locating slots. The shutter shaft has been shortened. Some of the input gears have been eliminated and new gears with a particular ratio added. The camera box is positioned on its side, relative to its normal position. The film entry opening has been cut out to the edge of the camera box and a similar opening has been placed on the opposite side. The film enters and leaves in an edge up position. The holddown-roller assembly which holds the incoming film against the main drive sprocket has been modified to include a double pip-time lamp housing. The buckle switch has been shifted in location relative to the take-up side of the main film-drive sprocket. Additional guide rollers have been placed in the feed and take-up sides about the film-drive unit for proper guidance of the film.

The main drive motor is located in the lower compartment of the camera drum and is supported in a bracket in which

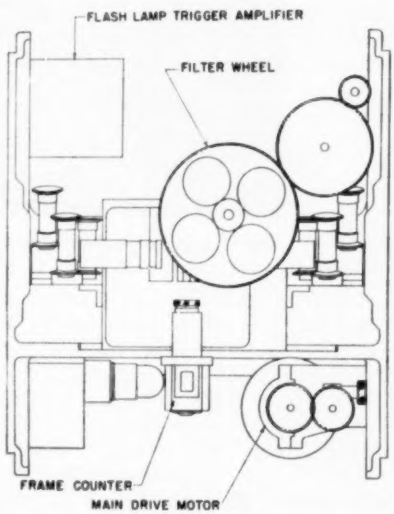

Fig. 8. Front elevation of camera drum.

the outer motor-housing ends are held in bearings; by means of a gear connected on one end of this housing and a mating gear and knob, the latter located outside the drum, the motor frame may be rotated and locked. The motor is $3\frac{1}{4}$ in. in diameter by $4\frac{1}{2}$ in. long. Its out-

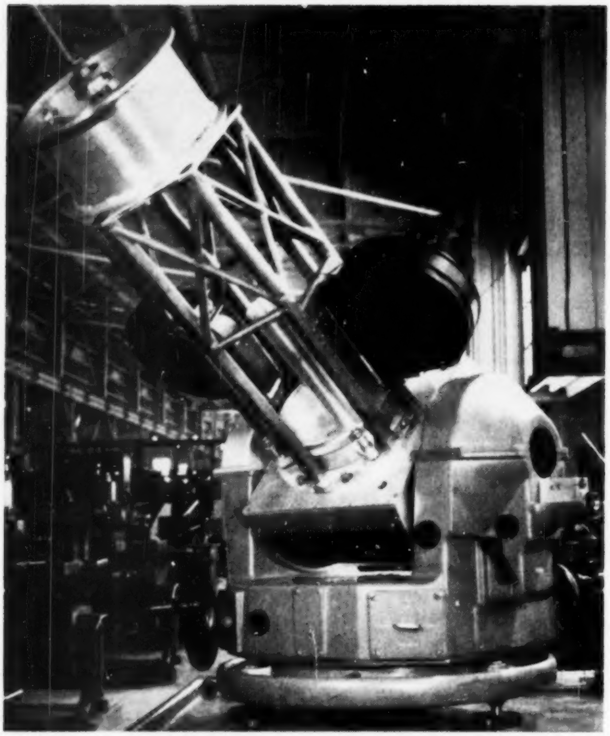

Fig. 9. Prototype of main tube assembly and camera drum.

put shaft is connected to a small gearbox which is in turn connected to the input of the camera gear mechanism.

The design has been arranged so that either of two types of motors may be used. The first or preferred type is a motor now in the process of development. It is a multifrequency synchronous motor of approximately 1/8-hp rating, designed to operate at any one of three frequencies: 60, 120 or 240 cycles/sec at approximately 115, 230 or 460 v, giving speeds of 1800, 3600 and 7200 rpm, respectively. This operation will provide film rates of 16, 32 or 64 frames/sec. This selection of frame rates is available to the operator by means of a switch.

The second type of motor is a conventional single-frequency (60 cycles/sec) single-speed, 110-v a-c synchronous, hysteresis type, 1800-rpm 1/20-hp rating. It can be operated through gearboxes, which must be changed before operation, to provide film rates of 16, 32 or 64 frames/sec.

The set of curves in Fig. 6 shows the various horsepower requirements at different frame speeds at normal temperatures. Laboratory tests were made with Mitchell high-speed movements at the three different frame rates both at normal and cold temperatures to determine the required torque output from a synchronous motor. Both old and new film movements were used. Figure 7 shows a typical curve of temperature affecting camera power requirements.

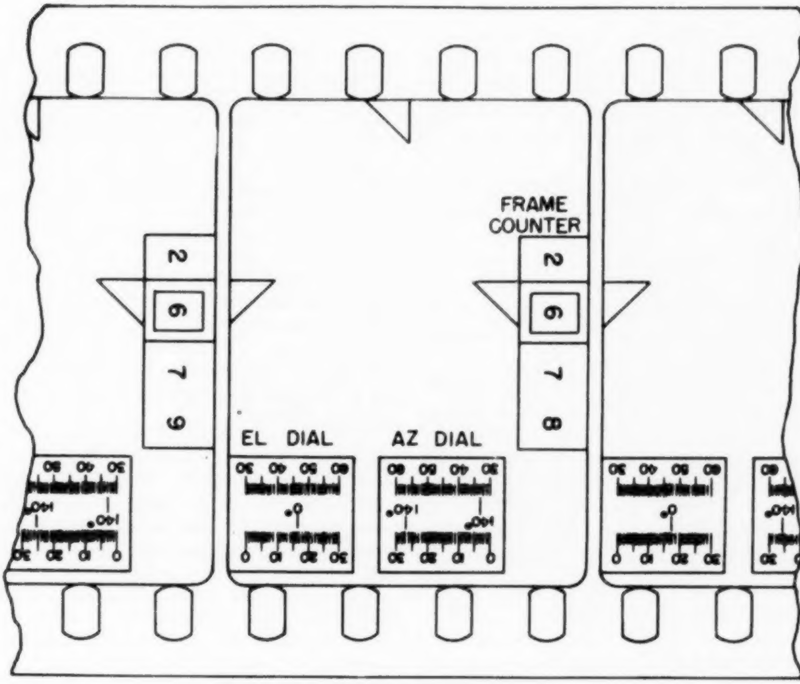

Fig. 10. 35mm frame presentation.

It is noted that from approximately 50 F upwards, the torque requirements are essentially the same, whereas around 0 F the torque requirements are approximately doubled. These results show at normal temperatures, approximately 1/200 hp for 16 frames/sec, 1/100 hp for 32 frames/sec, and 1/20 hp for 64 frames/sec. A value of 1/15 hp was assumed to be a normally desirable capacity; the actual motor may prove to be closer to 1/8 hp.

The motor may be brought to its highest operating speed gradually by either the use of a variable-frequency input to the motor amplifier or by going through the lower discreet frame rates first. When synchronous speed is reached, the frequency input to the motor amplifier comes from a frequency standard.

Figure 8 is a front-elevation view of the camera drum. A counter is located in the motor compartment and is geared to the camera mechanism to show successive frame counts. A gaseous discharge tube illuminates this counter which serves as an object for a lens-and-prism arrangement which produces an image on the film. One leaf of the adjustable shutter has a small slug of permeable iron mounted on it. An electromagnet is mounted on the camera body so that the outside edge of its core is close to the rotating shutter slug, producing a pulse which, when fed into a trigger amplifier, flashes the Edgerton lamps in the instrument; one lamp is located at the azimuth dial, one at the elevation dial and the other at the frame counter. The pickup coil is located so that the rotating slug will produce a signal when the center of the shutter opening is at the center

of the film-frame opening. When the shutter opening is changed, a variable resistance is set to produce enough pulse delay so that it still represents the center of the shutter opening at the center of the film frame. The instrument circuit is also designed to cause the Edgerton lamps to be flashed from external central timing pulses. The pulses from the shutter pickup are compared to the central timing pulses selected by the operator at 16, 32 or 64 frames/sec on a small dual tube oscilloscope located on the pedestal of the instrument; the motor frame is then moved until the pulses coincide in phase. The film is receiving central timing pulses as light pips which appear as 100 pulses/sec and coded elapsed time every second. Therefore, film records from all similar instrumentation on the same range may be easily compared together for the same time interval. A filter wheel containing four Wratten Series VI filters is located close by and in front of the film-frame aperture.

Figure 9 shows the prototype main optical tube and camera drum when the first unit was being constructed.

Figure 10 shows the film frame presentation, with azimuth, elevation and frame-counter dials and fiducial marks.

Discussion

Walter Beyer (Paramount Studios): In connection with the Mitchell movement I would like to know whether you replaced the shutter with another type?

Mr. Lipton: We are not using the venetian blind shutter. We are using the rotating, variable open type exactly as used on the Mitchell movement.

Mr. Beyer: I also want to mention that I spent 15 years in Germany with the company that manufactured these cinetheodolites, and I want to congratulate you on the improvements you have made.

Mr. Lipton: Thank you.

Mrs. Amy E. Griffin (Naval Ordnance Test Station): Have you given much thought to the problem of synchronizing the camera?

Mr. Lipton: I believe I mentioned that we are going to use synchronization in this system. The central time station will generate pulses at the frame rate at which the camera will be used. For example, they will generate 64 pulses per second to each field station. These will feed into a divider from which the operator will select 16, 32 or 64 pulses per second, corresponding to the frame rate at which he will operate the camera.

Mrs. Griffin: Do you have enough experience with these lenses to know how long they will stay in focus because of temperature conditions?

Mr. Lipton: We've had quite a bit of experience. What we normally do is check each day before shooting to make sure they are in focus. If we have a particular object distance and are intending to use the instrument for that, we have a calibration chart to show how much to move the secondary mirror for that particular object. For a short period of time, for example an hour, the focus will not change and, by the method we have outlined, it should be relatively simple for the operator to determine first the infinity focus position, because of the current temperature and light conditions, and then by the use of the precalculated chart, for example, move the secondary mirror the required amount for the object distance. I think this type of system has been used in the field, not precisely in the way I have described it, but by the same general philosophy of adjustment.

Mrs. Griffin: The reason I am interested is because we have used Cassegrainian lenses and then practically stopped using them because we couldn't keep them in focus long enough. I think the secondary mirror needs to have a very stable mount and one which will not vibrate and shake with the instrument as it is being used. We have pretty good luck with all refraction-type lenses.

16mm Projector for Full-Storage Operation With an Iconoscope Television Camera

By EDWIN C. FRITTS

A heavy-duty 16mm projector was described in 1950 by the author.[1] This projector has since been modified to adapt it to full-storage operation with a television camera. The modifications include a somewhat faster pulldown operating at the uniform rate of 24 frames/sec and a relay condenser system which, in combination with a special shutter and filters, provides adequate illumination of improved quality within blanking time. Operational facilities are also described. The accommodation problem of converting 24 frames/sec of motion pictures into 30 frames/sec for television is treated in an Appendix to the paper.

A PROJECTOR for presenting motion pictures on a screen illuminates the screen for as long a period as possible while allowing the minimum of time for film advancement. In full-storage operation with an iconoscope in a television camera the procedure is reversed. The film is illuminated for only the brief period of vertical blanking, when no image is seen, and the image is stored as an electrostatic charge on the mosaic. The mosaic is dark as it is scanned. Thus, the greater time of the scanning intervals is available for the advancement of the film. However, an element of incompatibility exists between the 24 frames/sec of motion pictures and the 30 frames/sec of television which can be met in either of two ways. By changing the phase of alternate pulldown actions, they can all be made to center on the television fields in the so-called 2–3–2 sequence, and the length of pulldown can fill the greater part of a field. Or, if the pulldown is made shorter than one-half a field, by an amount sufficient to take care of all the necessary tolerances, the uniform 24-frames/sec sequence can be fitted between the blanking intervals (see Appendix).

The projector to be discussed is a modification of the Eastman 16mm Projector, Model 25, which the author has previously described.[1] Let us consider first the basic modifications of this projector to meet the functional requirements as applied to its use in television. Then we will discuss the operational problems and, without too much detail, the means of meeting them.

Presented on May 1, 1951, at the Society's Convention at New York, N. Y. by E. C. Fritts, Camera Works, Eastman Kodak Company, Rochester, N. Y.
(Revised manuscript received on June 8, 1953.)

Fundamental Principles

These include: (1) a pulldown to operate at the uniform rate of 24 frames/sec and yet dodge the vertical blanking intervals, (2) the unique problem of the shutter and optical system as described, (3) the proper quality of the light for best response from the iconoscope and (4) a modification of the projection objective to work at a 1 to 12 magnification.

The Pulldown. This projector makes use of the shorter pulldown operating at the uniform rate of 24 frames/sec. Certain tolerances are necessary in the accommodation of this pulldown within the scanning time, or, more exactly, to dodge the transmission time of the shutter, which itself is contained within the blanking interval. These include phasing tolerance, tolerance in the adjustment of the pulldown to the shutter at the time of installation, and an allowance for framing, since framing alters the position of the pulldown with respect to the shutter. Reference is made in the original paper to the tuning of the coupling system between the intermittent and its individual motor. This tuning is adjusted, in the case of the television projector, to reduce the time of pulldown action to the required value.

The Shutter and Optical Systems. These items are considered together because of the unique problem inherent in such a projector. The angle of the shutter necessary to occult the optical system is always to be considered in the design of a shutter and optical system. The problem is unique in this case because of the very short time available for exposure. Should a shutter of the proper speed of 60 rps be placed in the position ordinarily used, that is immediately behind the gate, the occulting angle would equal approximately the total available angle of transmission and leave little or no angle for an opening in the shutter.

To meet this condition, we must reduce the diameter of the cross section of the light beam or use a larger shutter, or both. The use of a relay optical system makes it possible to contain the light in a small aerial image of the filament. This image is also formed to the rear of the mechanism, in the normal position for the lamp filament, which provides clearance for a large shutter. Thus, the efficiency of the shutter is raised to where sufficient illumination is obtained from a 1000-w, 10-hr lamp.

Grimwood and Veal[2] have found that the response characteristics of the iconoscope are improved if the quality of the radiation from a tungsten source is altered, particularly to remove a portion of the spectrum in the red and infrared. Filters are placed in the optical system for this purpose.

The projection lens must image the film at a 1 to 12 magnification. The lenses used in the Model 25 were described by Schade.[3] A 4-in. lens of this design is fitted with a compensator which essentially permits the basic objective to occupy the exact position it would be in when projecting onto a distant screen without the compensation. Thus the excellent corrections are preserved.

Operational Conditions

We now consider those features of the projector which pertain specifically to the problem of manipulation. These include: (1) arrangement of parts to fit into a multiplexing combination of more than one projector for one television camera, (2) the separate shutter motor, (3) controls for remote operation, (4) controls to assure proper phasing of shutter to vertical blanking and of the pulldown to the shutter, (5) still-picture operation and (6) the special preamplifier.

Arrangement of Parts. A mirror is generally placed between the projection objective and the iconoscope for multiplexing, and the mounting of this mirror comes close to the front of the projector. Hence it is necessary to move the film reels backwards from their position on the Model 25, as will be seen in Fig. 1. The 4-in. lens is used to provide an optical system of sufficient length for the necessary clearance.

Separate Shutter Motor. The separation of the mechanism of the Model 25 Projector into two completely independent units with separate synchronous motors is the main reason for the low noise and flutter and long life of the mechanism. For the same reasons the shutter of the television modification is driven by a separate three-phase synchronous motor running at 3600 rpm. The greater speed and larger moment of inertia of this shutter and the requirement for greater stability have determined the choice of the three-phase operation and the generous size of the motor. When synchronous motors are linked to large moments of inertia, as is the case with this shutter, the limiting factor in the size of the motor is its capacity to pull the shutter mass into synchronism. A three-phase motor permits starting without an internal switch and is more stable in operation than a single-phase motor.

An additional and equally important reason for the separate shutter motor is to shorten the starting and stopping wastage of film by letting the heavy shutter system coast to a stop independent of the mechanism which stops much more rapidly. The time of starting is short because the large torque required for the "pull into synchronism" is available for greater acceleration in starting.

Controls. The requirement of remote operation calls for a more complicated switching system including a number of

Fig. 1. The Eastman 16mm Television Projector Model 250

relays. This will not be described in detail. It provides for a rather flexible adjustment to studio conditions, for operation from the projector and the monitor positions and includes a douser and provision for still pictures.

Phasing. Two elements of phasing are involved: (1) the shutter opening must occur at the vertical blanking time and (2) the pulldown must dodge this open time.

The motors are all of the salient pole type. Because of the two possible magnetic polarities on the poles of the rotors, they can occupy either of two positions in rotation with respect to the waveform of the power supply, 180 electrical degrees apart. For the two-pole shutter motor, this separation represents 180 mechanical degrees, while the four-pole mechanism motor shifts 90 degrees and the pulldown motor shifts 72 degrees, if the polarity is reversed. Once the pulldown is adjusted to miss the shutter openings, the reversal of polarity in the mechanism motors is of no consequence when the short pulldown is used. With the longer 2–3–2 action these motors would need to be phased at each starting. This problem is treated in more detail in the Appendix.

The shutter opening must occur at the time of vertical blanking. Accordingly, on installation, it must be adjusted in rotation with respect to the motor rotor until this is true. In operation, the choice of polarity of the rotor is necessary to have the exposure occur properly during blanking time rather than as a "shutter bar" in the middle of scanning. This choice is made each time the motor starts. The intelligence for this choice is a half-wave rectified power supply. A commutator on the motor shaft closes two contacting brushes once per revolution. This contact occurs either at the peak of the half-wave voltage or midway in the blocking period of the rectifier when no voltage occurs. In the former case, a pulse of current closes a relay which momentarily opens the motor circuit, causing it to slip a pole. Then the contact will occur at the time of no voltage, and the phasing is correct. When the "On" button is pressed, a motor-driven switch operates through a 4-sec sequence which actuates a solenoid to bring the brushes into momentary contact and then removes them. Phasing is accomplished during this time. This same switch changes the lamp from a standby low voltage to operational voltage. The resulting slow switching of the lamp has much to do with contact life of the switch. Pressing the "Off" button rotates the switch to the off position.

Still-Picture Projection. Another advantage of a separate shutter motor is in the projection of a single frame. Since most of the infrared is removed from the radiation by filters, a single frame can be projected indefinitely. While the shutter is running, the lamp can be operated at normal voltage, and the projector may be interchanged between still and motion projection by merely starting and stopping the mechanism.

Preamplifier. The photoelectric cell feeds into a special preamplifier with a maximum output of 14 dbm. The equalization curves are shown in Fig. 2. The output transformer has a choice of impedance of 75, 150, 300 or 600 ohm.

This projector known as the Eastman 16mm Television Projector Model 250 is designed, as is the Model 25, for long life, high-quality operation and low noise, both mechanical and electrical. The control system, while of necessity more complicated than in the Model 25, is easily accessible for servicing. Troublesome elements are avoided throughout as far as possible, particularly where they might not be readily accessible. The absence of enclosed starting switches in the motors is such a case. Also, the shutter motor

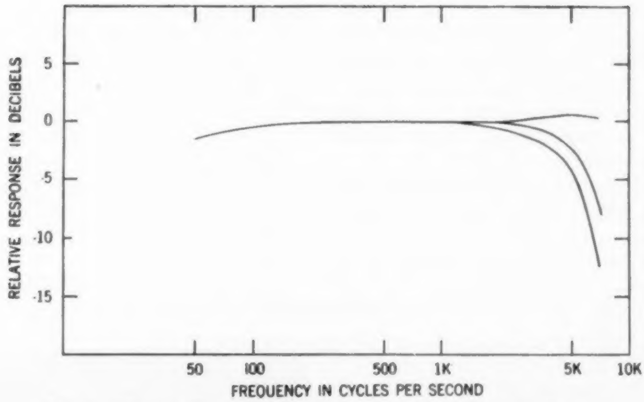

Fig. 2. The audio-response characteristics of the projector.

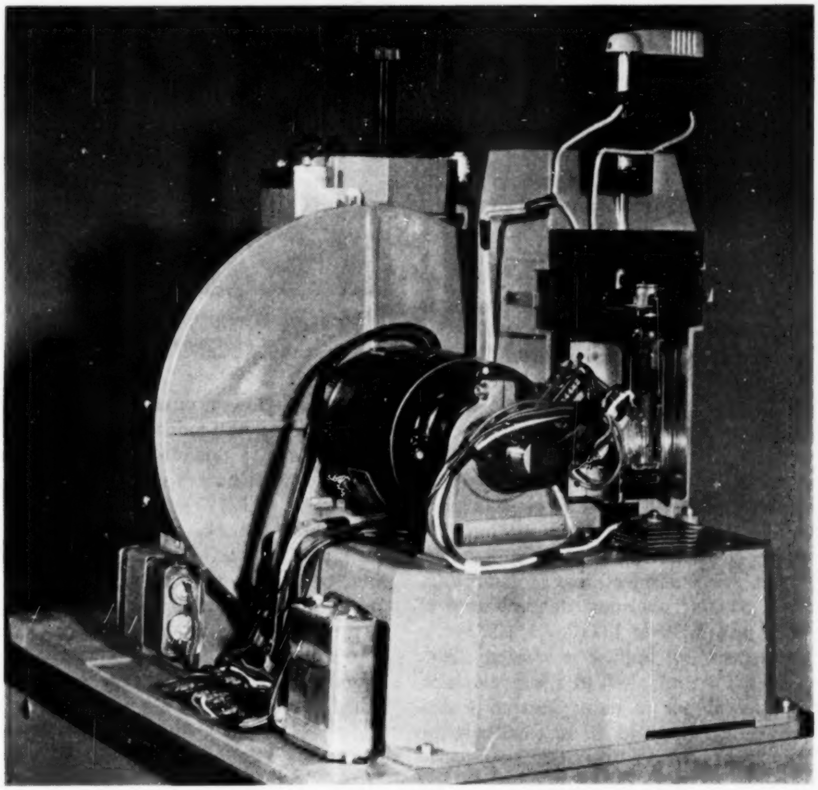

Fig. 3. Rear view of exposed mechanism.

has no winding on the rotor. This avoids a d-c power supply, the collector ring and the winding itself. A failure of any of these would disable the motor. Rather, the phasing mechanism is all external to the motor, simple, and easily accessible for servicing. Figure 1 shows the general view of the projector. Fig. 3 shows the rear view with case removed.

References

1. E. C. Fritts, "A heavy-duty 16mm sound projector," *Jour. SMPTE, 55:* 425–438, Oct. 1950.
2. T. G. Veal and W. K. Grimwood, "Use of color filter in a television film camera chain," *Jour. SMPTE, 57:* 259–266, Sept. 1951.
3. W. E. Schade, "A new *f*/1.5 lens for professional 16mm projectors," *Jour. SMPTE, 54:* 337–344, Mar. 1950.

APPENDIX

The accommodation of 24 frames/sec for motion pictures to 30 frames, 60 fields/sec for television presents a difficult problem in the application of motion pictures to television. Less than 1 msec is available for film movement if the conventional motion-picture practice is followed of advancing the film when no picture information is presented. Such a rapid pulldown would involve, as a general observation, fifty times the magnitude of forces as occur in a 60° pulldown used in motion-picture projection.

In projecting into an iconoscope of a television camera, a dodge of this problem is followed. The exposure is made when picture information is not presented, that is, during vertical blanking time. The iconoscope will remember the exposure as an electrostatic image which is removed during scanning to produce the picture signal. Thus, we have the whole scanning time in which to advance the film. This time is quite ample except for the 24-frame and 30-frame relationship.

Let us consider this relationship. The greatest common denominator of 1/24 and 1/30 is 1/120. 1/120 sec is equivalent to half a television field. 1/24 sec is equivalent to 5/2 a television field, 1/30 sec is equivalent to 4/2 a television field, and 20 half-fields is the minimum number to contain an integral number of both motion-picture frames and television frames.

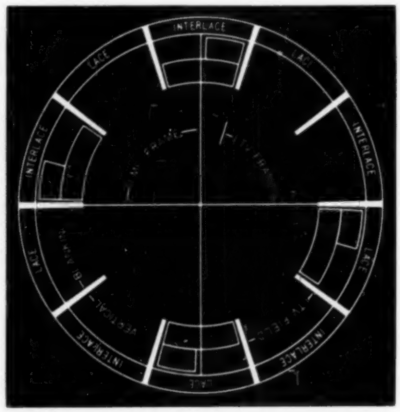

Fig. 4. Motion-picture and television relationship.

Figure 4 shows a circular chart of ten fields. Since half-fields are a common denominator in this scheme of things, a pulldown which takes place in less than a half-field, or 1/120 sec, and at a regular interval of 1/24 sec, can be so phased on our chart as always to miss the blanking time when the exposure is made. The four outermost and smaller boxed segments on our chart represent such a placement of pulldown actions. The larger outlined segments represent a so-called 2–3–2 pulldown sequence. This sequence, it will be seen, is alternately spaced by two fields and three fields. Either sequence misses the blanking times. Thus motion pictures can be

projected into television on a storage basis at the uniform rate of 24 frames/sec if the pulldown actions occupy less than half a field. Or, the lengths of pulldown may be approximately twice this length if alternate actions are spaced by two and three television fields, that is by 2/60 sec and 3/60 sec. The average of 2/60 and 3/60 equals 1/24.

We should also observe a difference between these two types of action when the phase of either is shifted one-half a field with respect to the blanking-time sequence. Such a shift is the result of a reversal of polarity in the rotor of a synchronous motor. In the case of the shorter regular sequence, they will always miss while the longer 2-3-2 sequence will fall astride the blanking times if the phase is shifted one-half field from that shown in the chart.

Thus the 2-3-2 sequence requires that the polarity of the motor driving the pulldown be always the same, while this is of no significance with the shorter and uniform 24-cycle sequence.

Errata

George R. Groves, "Progress Committee Report," *Jour. SMPTE, 60:* 535–552, May 1953.

In preparing final proofs, under the subheading "Film Processing Laboratories," a regrettable wrong transposition and error were perpetrated. The fifth and sixth paragraphs of that section should have begun with the following information, respectively:

Consolidated Film Industries constructed a new laboratory building to be used exclusively for 16mm processing and printing . . . ."

"*General Film Laboratories* was a new entry into the independent laboratory field, having taken over the former Paramount facility. . . ."

1953 (Issue No. 2) SMPTE Television Test Film:

Operating Instructions

PURPOSE

The Television Test Film is intended to provide a means by which performance tests of a television film reproduction system can be made on a routine operational basis. Its test sections are chosen to emphasize errors of physical alignment and electrical adjustment in such a way that needed corrections become apparent. It is suggested that the reel be run through all projection equipment at regular intervals to provide a standardized indication of normal operation. In this way equipment malfunction may be detected before its effect becomes serious.

This film is not intended to be a laboratory instrument, although it may be useful in product designing and testing.

CONTENTS

Six test sections and a selection of scenes comprise the complete film, which is available in either 16mm or 35mm widths. The test sections are geometrical patterns intended to present information on the factors most likely to be degraded in television film reproduction. Each chart selects some particular failing of the average system and produces a signal intended to exaggerate and thus clearly define any deviation from normal operation. Perfect reproduction of all the charts is to be desired, but some degradation of each is to be expected. Experience will show the magnitude of these effects which may be considered normal for any particular system.

Scenes representative of many types of pictures encountered in television films are included in the reel as a final qualitative test of overall results.

Sec. 1. Alignment and Resolution (See Fig. 1)

This pattern defines the portion of the projected film frame which is to be reproduced by the television system, permitting accurate alignment of the motion-picture projector with the television camera. Eight arrow points have been positioned to touch the edges of the picture area to be scanned. This

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On January 23, 1953, a meeting of the Films for Television Committee was called by Dr. Raymond L. Garman, Chairman, for the purpose of reaching a decision on a number of changes in the television test film which had been under consideration for some time.

Agreement was reached on changes modernizing the main title, changes in the wording of some section target titles, changes in length of revised sections, elimination of the 1–3–1 step gray-scale target and lengthening the section showing the target with two seven-step tablets.

It was agreed to accept the compromise proposal on picture size for use in setting the dimensions of the alignment target at the arrow points. This means that for 35mm, the reproduced dimensions will be $0.594 \pm 0.002 \times 0.792 \pm 0.002$ in. which, when reduced by the standard ratio of 2.15, will give a 16mm size of $0.276 \pm 0.002 \times 0.368 \pm 0.002$ in.

Charles L. Townsend presented a new target, combining the alignment and resolution tests, which after careful consideration was approved. The committee gratefully extended its thanks to Mr. Townsend and NBC for their excellent work in preparing this target and for their generosity in making it available to the Society without charge.

These changes have been made in the film, and the operating instructions (originally published in the *Journal* in February 1950, pp. 209–218) revised accordingly.

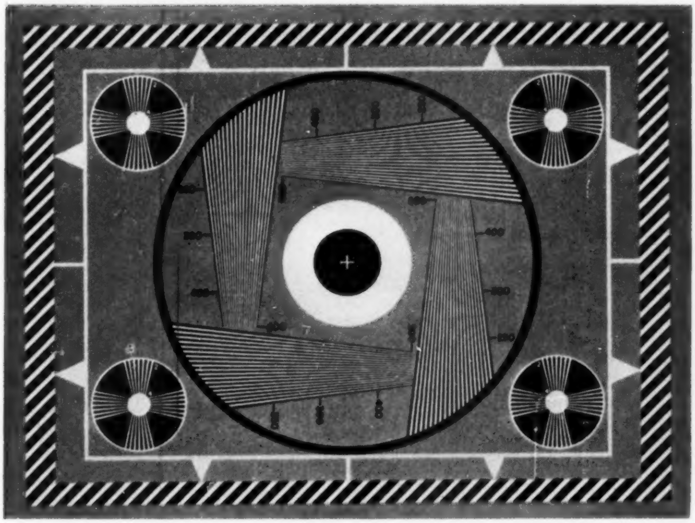


Figure 1

"active area" conforms with a proposed standard developed by a joint RTMA/SMPTE committee representing the industry as a whole. It is intended to be used by producers of films for television as well as broadcasting stations to insure accurate scene-content reproduction. The area outside the arrow points has been striped with a "barber-pole" effect which extends to the limit of the printer aperture. When the projector is positioned correctly and scanning is adjusted perfectly all the picture frame to the arrow tips will be reproduced on the television system, but none of the striped area will show.

It should be noted that the striped area is wider on the sides of the frame than on the top and bottom. This results from the fact that the standard projection aperture does not have a four-to-three ratio but is wider by some 3% (see the American Standards for Picture Projection Apertures, Z22.58-1947 and Z22.8-1950). It may be necessary in some 35mm projectors to enlarge the projection aperture vertically to show some barber-pole across both the top and the bottom of the picture. This is advisable to allow for small scanning irregularities and centering drifts without loss of active picture area. When such irregularities are encountered, size and centering controls should be adjusted to reproduce as much of the "active area" as possible even though some barber-pole may be reproduced. Experience will dictate what compromise settings are required by opposing drift and picture-loss considerations.

At the base of the arrow heads is a white line forming a rectangle which defines a 5% border around the active area. That is, the lines at the top and bottom are placed in from the edges by 5% of the height, and the lines at the sides are placed in from the edges by 5% of the width. These dimensions permit rough estimates of the magnitude of scanning irregularity or misalignment through visual comparison of the effects in question with the size of the border. Specific values for misalignment obtained in this manner can be logged

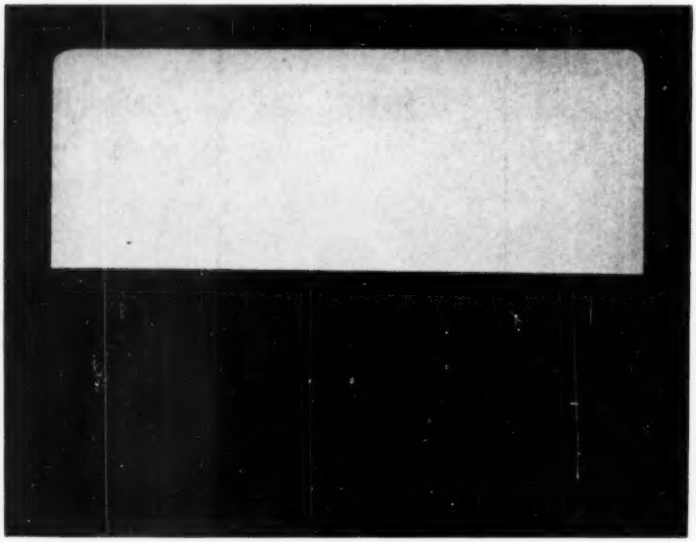


Figure 2

easily for future reference as part of a quality-control program.

White lines are provided in the center of each edge, and a cross is located in the exact center of the pattern to aid in alignment of the optical pattern on the pickup-tube plate.

A gross estimate of scanning-distribution errors can be obtained by observing the "roundness" of the large circle. Localized errors will show up as deformations of the small central circles or those in the corners of the pattern. Observations of this sort require a carefully calibrated picture monitor to insure that all defects noted are in the film-scanning system and not in the picture monitor. It should be noted that the arrows are equally spaced with respect to the corners and center lines. When scanning defects are noted, a ruler laid along the calibrated monitor picture will indicate the place and size of the scanning error.

Overall system resolution is indicated by the converging line wedges in the pattern. By noting the point at which the individual lines making up the wedges are no longer visible separately, an estimate of the value of system resolution can be made from the calibration adjacent to that point. The calibrations are in television system lines. The small corner wedges are marked in hundreds of television lines. These wedges may be used for checks of both optical and electrical focus.

Sec. 2. Low-Frequency Response (See Fig. 2)

This test is made in two parts, each consisting of a half-black/half-white frame, with the dividing line horizontal. The first section has the black portion at the top of the frame and the second is black at the bottom. These charts produce 60-cycle square-wave signals. When viewed on the waveform monitor set for field-rate deflection, the signals should appear reasonably square. Serious tilting or bowing indicates incorrect low-frequency phase and amplitude response. When the system has been set for reproducing the first chart, the

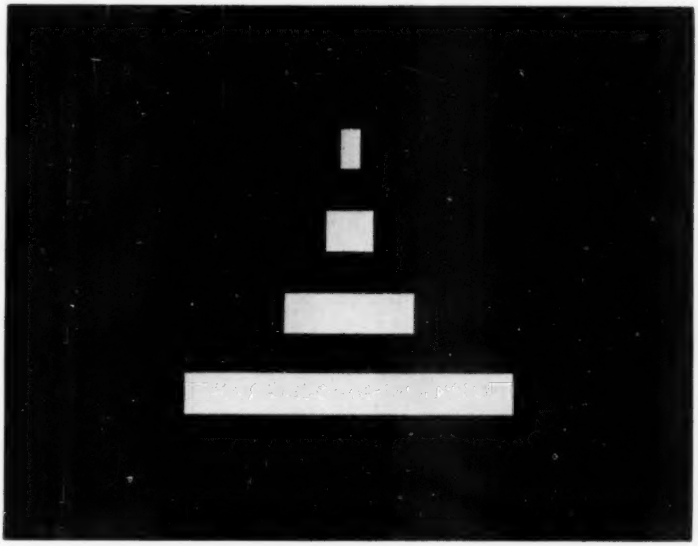


Figure 3

change to the second chart should not necessitate large shading changes.

The chart which is black at the bottom also permits a check on the amount of flare encountered in iconoscope operation. Rim lights and beam current should be reset if the flare is excessive.

Sec. 3. Medium-Frequency Response (See Fig. 3)

The response of the television system to medium-frequency signals is of importance to picture quality. In this test, horizontal bars are used, first as black on white and then reversed. The bars have lengths equal in time of scanning-beam travel to 2, 5, $12\frac{1}{2}$ and 32 microseconds. These correspond to half-wave pulses covering an approximate fundamental frequency range from 15 to 250 kilocycles. Correct medium-frequency phase and amplitude response will be indicated by leading and trailing edges of the bars having no long, false gray tones. If, following the trailing edge of a bar, a streak appears having a tone similar to that of the bar (white after white, black after black), then it is reasonable to assume that the amplitude of the frequency represented by that bar is too great, or that its relative phase is incorrect. If the opposite occurs, as a white streak after a black bar, the fundamental frequency is too low in amplitude, and its relative phase is in error.

Sharp transient effects immediately following all bars are an indication of excessive high-frequency response. This condition will usually be clearly indicated in the test for resolution.

If very long streaking occurs in which the spurious signals are seen on the left side of the bars, as well as on the right, an investigation of the low-frequency response of the system should be made. Under these conditions close examination of the previous charts should reveal errors of waveform.

It is rarely possible to obtain perfect streaking-free reproductions of both the black-on-white and the white-on-black charts with one setting of the controls. The settings which produce very small

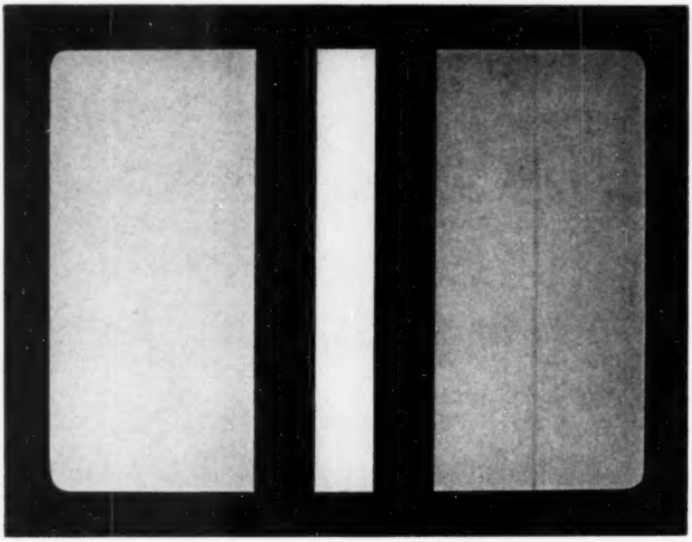


Figure 4

streaking equally on both charts are usually preferred.

Sec. 4. Storage (See Fig. 4)

Film pickup systems which utilize short pulses of light must store the charge produced by the pulse long enough to permit the charge image to be scanned. Since the beam starts the scanning process at the top of the picture, the storage time required is maximum at the bottom of the picture. Some pickup tubes will suffer from leakage to the extent that the charge image may be seriously reduced in amplitude by the time the beam reaches the bottom of the picture.

The chart which checks this characteristic is made up of vertical black and white stripes on a gray background. When viewed on the waveform monitor (set at field rate) this pattern will produce three lines representing white, gray and black. Shading should be set to hold the gray line parallel with the blanking axis. If the white and black lines then tend to converge, the pickup tube does not have perfect storage. Perfect results are indicated when all traces are parallel. If the black-to-white amplitude at the bottom of the picture is divided by that at the top of the picture, the tube's storage factor is obtained. This is usually expressed in percentage.

Sec. 5. Transfer Characteristics (See Fig. 5)

The ability of a television system to reproduce shades of gray is indicated in this section through the use of step-density areas. The chart consists of two step-density tablets showing seven steps each. The direction of progression of the second tablet is opposite to that of the first to provide maximum values at each side of the picture frame.

The neutral gray background of this chart should be shaded flat, and gain and brightness settings should be adjusted to give normal waveform-monitor amplitudes. Under these conditions each step should be visually compared with the adjacent steps, both in the

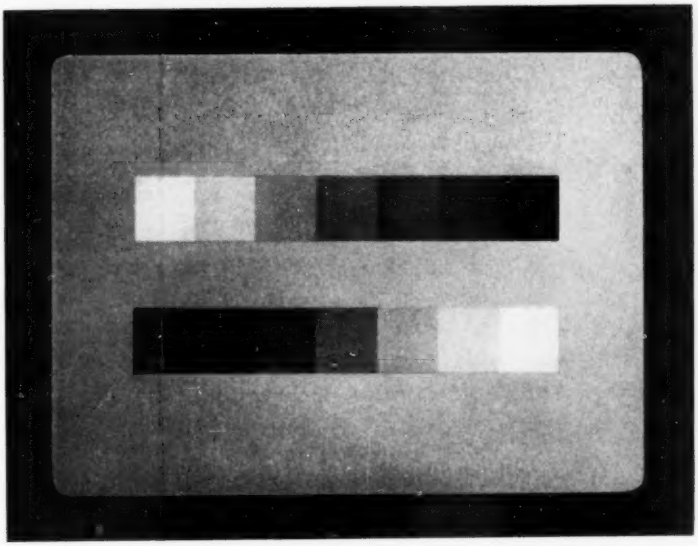


Figure 5

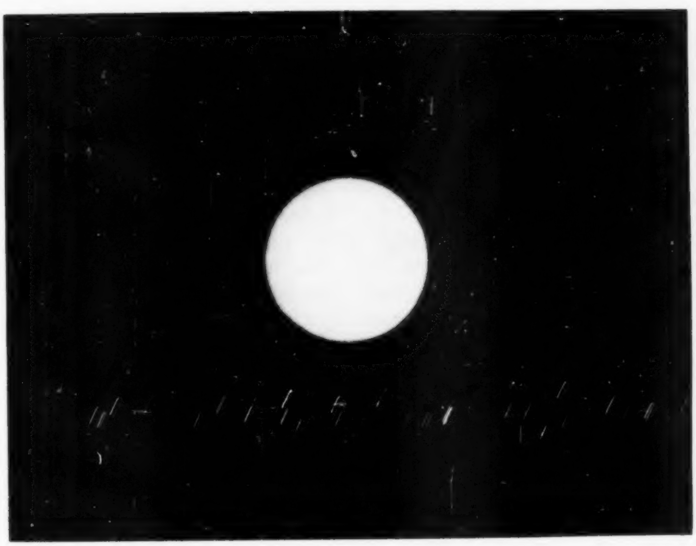


Figure 6

Figure 7

picture and on the waveform monitor, and each should be clearly defined. Compression effects will be seen as a cramping together of adjacent steps. Experience as to the appearance of the tablets will establish a norm from which variations can be noted.

The effective transfer characteristic of a film-pickup system is a function of both film density and projected illumination. This test film has a range considered to represent that normally encountered in practice. If significant compression occurs, projector brightness should be checked. Other factors, including beam current, bias-light, and clipper adjustments should be tested with a stationary slide.

Sec. 6. Automatic Brightness Control (See Fig. 6)

This test indicates the ability of the television system to follow changes in average illumination of a series of scenes. It consists of a white disk centered in a black frame which enlarges slowly to fill the whole frame. As the white portion becomes larger, the brightness control should hold the black level constant. On the waveform monitor, the black signals should remain fixed, in position relative to the blanking level. The first brightness changes on the film are both slow and even, so that systems with slow-acting control should be able to follow them accurately.

The second portion of the test consists of sudden changes in white disk size from the smallest size to one third of the frame area and then to two thirds of the frame area. Experience will show how much error in black-level setting results in these cases on a transient basis.

Sec. 7. Typical Scenes (See Fig. 7)

To provide a qualitative check on the overall results to be expected from good film, several scenes taken from material used specifically for television are included in the test reel. Utilization of this section will depend upon the operator's experience in judging acceptability and upon his memory of "how they looked before."

Two Proposed American Standards—PH22.95, PH22.96

Television Picture Area—35mm and 16mm Motion-Picture Film

Two proposed American Standards on 35mm and 16mm television picture area are published on the following pages for 3-month trial and criticism. All comments should be sent to Henry Kogel, Staff Engineer, prior to November 1, 1953. If no adverse comments are received, the proposals will then be submitted to ASA Sectional Committee PH22 for further processing as American Standards.

The two proposals are consistent with existing standards for camera and projector apertures, with one exception. The standard 35mm projector aperture was considered unsatisfactory for television use because its aspect ratio is not 4 by 3 and because its specified height results in a loss of picture area that was considered by many to be excessive. The present proposal increases the height of the 35mm projector aperture as much as possible without requiring enlargement of the 16mm projector aperture, thus permitting reproduction of optical reduction prints. Enlargement of the 35mm aperture is considered permissible because the number of 35mm projectors now in television use is not great and because the construction of 35mm equipment makes alteration or replacement of the aperture a very simple matter. — *F. N. Gillette*, Chairman, Television Film Equipment Committee.

Proposed American Standard **Television Picture Area—35mm Motion-Picture Film** (Third Draft)	**PH22.95**

1. Scope

1.1 The area to be included in a television picture is determined at the point of origination of the program concerned. In subsequent treatment of the resulting picture, it is very important that excessive cropping of the edges of the picture be avoided. The purpose of this Standard is to establish operating procedures which will minimize the loss in area sustained in recording a television picture on 35mm film and in subsequently reproducing the film with a television film chain, and also to prevent the televising of a black or white band formed by the edge of the recorded area or the projector aperture.

1.2 Since the film chain equipment will also be used, without intervening readjustment of the equipment, for reproduction of films produced by standard photographic techniques, the Standard provides for optimum utilization of the picture area of standard 35mm motion-picture film.

1.3 Film prepared by conventional photographic techniques for television reproduction shall be prepared in accord with the provisions of Z22.59–1947, Photographing Aperture of 35mm Sound Motion Picture Cameras, or the latest revision thereof, approved by the American Standards Association, Incorporated, which specifies the location and size of the camera aperture. The loss of significant picture information in television reproduction can be avoided by providing in the camera viewfinder an indication of the area to be scanned in television reproduction.

1.4 Paragraph 2 of this Standard applies only to video recordings intended for reproduction by a television system. If the video recording is intended for direct projection to a theater screen the image dimensions, with the exception of picture width, are adequately specified by American Standard Z22.59–1947, or the latest revision thereof. For the correct aspect ratio the image width should be 0.841 $\pm$ 0.004 inch.

2. Video Recording on 35mm Motion-Picture Film

2.1 The picture aperture of a 35mm television recording camera shall be in accord with American Standard Z22.59–1947, or the latest revision thereof.

2.2 The television picture appearing on the picture tube of the video recording equipment shall produce an image on the recording film having a height of 0.612 $\pm$ 0.004 inch and a width of 0.816 $\pm$ 0.004 inch.

2.3 The center point of the image shall coincide with the center point of the picture aperture of a 35mm motion-picture projector as specified by American Standard Z22.58–1947, Picture Projection Aperture of 35mm Sound Motion Picture Projectors, or the latest revision thereof, approved by the American

NOT APPROVED

Standards Association, Incorporated. (This actually serves to locate the image relative to the film.)

3. Television Reproduction of 35mm Motion-Picture Film

3.1 Except for height and width dimensions the picture aperture of a 35mm television projector shall be in accord with American Standard Z22.58–1947, or the latest revision thereof. The height dimension shall be 0.612 ± 0.002 inch and the width dimension shall be 0.816 ± 0.002 inch.

3.2 The portion of a 35mm motion-picture film reproduced by a television film chain shall be an area having a height of 0.594 ± 0.004 inch and a width of 0.792 ± 0.004 inch.

3.3 The center point of the reproduced portion of the film shall coincide with the center point of the picture aperture of a 35mm motion-picture projector as specified by American Standard Z22.58–1947, or the latest revision thereof. (This actually serves to locate the reproduced area relative to the film.)

NOT APPROVED PH22.95

Proposed American Standard

Television Picture Area—16mm Motion-Picture Film

(Third Draft)

PH22.96

1. Scope

1.1 The area to be included in a television picture is determined at the point of origination of the program concerned. In subsequent treatment of the resulting picture, it is very important that excessive cropping of the edges of the picture be avoided. The purpose of this Standard is to establish operating procedures which will minimize the loss in area sustained in recording a television picture on 16mm film and in subsequently reproducing the film with a television film chain, and also to prevent the televising of a black or white band formed by the edge of the recorded area or the projector aperture.

1.2 Since the film chain equipment will also be used, without intervening readjustment of the equipment, for reproduction of films produced by standard photographic techniques, the Standard provides for optimum utilization of the picture area of standard 16mm motion-picture film.

1.3 Film prepared by conventional photographic techniques for television reproduction shall be prepared in accord with the provisions of American Standard Z22.7–1950, Location and Size of Picture Aperture of 16mm Motion Picture Cameras, or the latest revision thereof, approved by the American Standards Association, Incorporated, which specifies the location and size of the camera aperture. The loss of significant picture information in television reproduction can be avoided by providing in the camera viewfinder an indication of the area to be scanned in television reproduction.

1.4 Paragraph 2 of this Standard applies only to video recordings intended for reproduction by a television system. If the video recording is intended for direct projection to a theater screen the image dimensions are adequately specified by American Standard Z22.7–1950, or the latest revision thereof.

2. Video Recording on 16mm Motion-Picture Film

2.1 The picture aperture of a 16mm television recording camera shall be in accord with American Standard Z22.7–1950, or the latest revision thereof.

2.2 The television picture appearing on the picture tube of the video recording equipment shall produce an image on the recording film having a height of 0.285 $\pm$ 0.002 inch and a width of 0.380 $\pm$ 0.002 inch.

2.3 The center point of the image shall coincide with the center point of the picture aperture of a 16mm motion-picture camera as specified by American Standard Z22.7–1950, or the latest revision thereof. (This actually serves to locate the image relative to the film.)

3. Television Reproduction of 16mm Motion-Picture Film

3.1 The picture aperture of a 16mm television projector shall be in accord with American Standard Z22.8–1950, Location and Size of Picture Aperture of 16mm Motion Picture Projectors, or the latest revision thereof, approved by the American Standards Association, Incorporated.

NOT APPROVED

3.2 The portion of a 16mm motion-picture film reproduced by a television film chain shall be an area having a height of 0.276 ± 0.002 inch and a width of 0.368 ± 0.002 inch.

3.3 The center point of the reproduced portion of the film shall coincide with the center point of the picture aperture of a 16mm motion-picture projector as specified by American Standard Z22.8–1950, or the latest revision thereof. (This actually serves to locate the reproduced area relative to the film.)

NOT APPROVED **PH22.96**

CORRECTION — PH22.53-1953

Method of Determining Resolving Power of 16mm Motion-Picture Projector Lenses

THIS AMERICAN STANDARD, last published in the May 1953 *Journal*, is reprinted on the two following pages, with typographical corrections made in paragraph 2.1.1 and in the first line of the Note directly under the title of Fig. 3.

AMERICAN STANDARD

Method of Determining Resolving Power of 16mm Motion-Picture Projector Lenses

ASA
Reg. U. S. Pat. Off.

PH22.53–1953

Revision of Z22.53–1946
*UDC 778.55

1. Scope

1.1 This standard describes a method of determining the resolving power of projection lenses used in 16mm motion-picture projectors. The resolving power shall be measured in lines per millimeter.

2. Test Method

2.1 The lens to be tested shall be mounted in a special test projector. A glass plate test object, carrying patterns of lines, shall be then projected upon a white matte grainless screen located at such a distance from the projector that the projected image of the border of the test object measures 30 × 40 inches. The resolving power of the lens is the largest number of lines per millimeter in the test object pattern that an observer standing close to the screen sees definitely resolved in both the radial and tangential directions. Lines shall not be regarded as definitely resolved unless the number of lines in the image is the same as the number of lines in the test object.

2.1.1 The patterns of lines shall consist of parallel black lines 2.5/X mm long and 0.5/X mm wide with a clear space 0.5/X mm wide between the parallel lines, where X equals the number of lines per millimeter.

2.2 Care shall be taken to insure that the screen is perpendicular to the projection axis and that the lens is focused to give the maximum visual contrast in the fine detail of the central image.

3. Test Projector

3.1 The projector design shall be such that the glass plate test object is held in proper relation to the lens axis. It shall not heat the test plate to a temperature which may cause the plate to be fractured or otherwise damaged. The emulsion side of the test plate shall be toward the projection lens.

3.1.1 The cone of light supplied by the projector shall completely fill the unvignetted aperture of the test lens for all points in the field. This may be verified by lowering the lamp voltage and looking back into the projection lens through holes in the projection screen situated at the stations A, B, C, etc. It can then be easily seen whether the lens aperture is properly filled with light.

4. Test Object

4.1 The glass photographic plate used for making the test object and the lens used in making the reduction of the master test chart shall have sufficiently high resolving power to insure clear definition of all lines in the patterns on the test object.

4.2 The photographic reduction of the master test chart shall be such that the test object border has a height of 7.21 mm (0.284 inch) and a width of 9.65 mm (0.380 inch) with a radius of 0.5 mm (0.02 inch) in the corners, and such that the sets of lines in the reduced image are spaced 20, 30, 40, 50, 60, 80, and 90 lines per millimeter.

Approved April 16, 1953, by the American Standards Association, Incorporated
Sponsor: Society of Motion Picture and Television Engineers

*Universal Decimal Classification

Printed in U.S.A.
ASA½M653

Price, 25 Cents

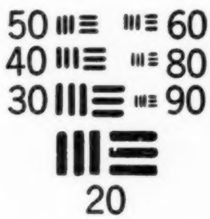


Fig. 1. Resolution Test Patterns (× 100 Diameters).

4.3 The patterns on the test object shall be in accordance with Fig. 1.

4.4 The position of the test patterns on the test object shall be in accordance with Fig. 2.

4.5 Identification of the positions of the test patterns on the test object shall be in accordance with Fig. 3.

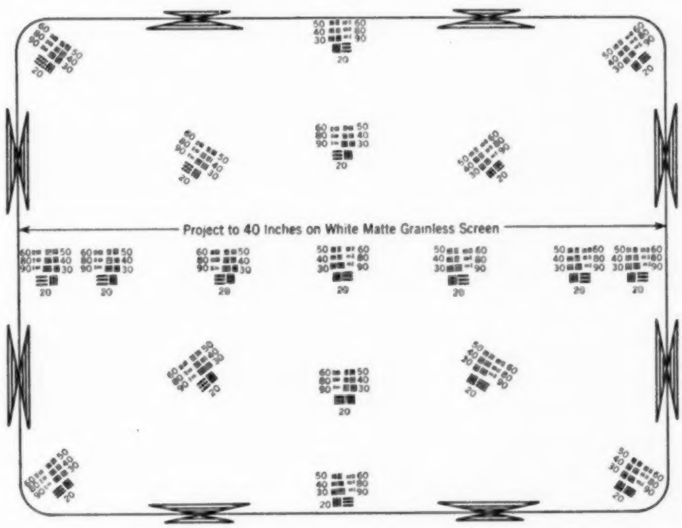


Fig. 2. Resolving Power Test Object (× Approximately 15 Diameters).

Note: The triangular edge patterns are to facilitate alignment of test plates in the projector.

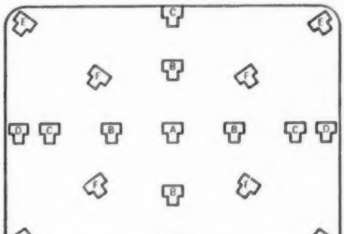


Fig. 3. Identification of Test Patterns in Frame Area.

Note: When using a 2-inch focal length lens, B corresponds to 2 degrees from the axis, C corresponds to 4 degrees from the axis, D corresponds to 5 degrees from the axis, E corresponds to 6 degrees from the axis, and F corresponds to 3 degrees from the axis.

Note: Glass test plates in accordance with this standard are available from the Society of Motion Picture and Television Engineers, 40 West 40th Street, New York 18, N.Y.

PH22.53–1953

1953 Convention of the NEA Department of Audio-Visual Instruction

By D. F. LYMAN

THE 1953 CONVENTION of the Department of Audio-Visual Instruction of the National Education Association was held in St. Louis, February 24 to 28. This year, with 727 registrants, the attendance was about twice that reported last year.* There were representatives from 42 states, two provinces of Canada, Pakistan, Thailand, the Philippines and Egypt. The writer of this review attended as a representative of the Society of Motion Picture and Television Engineers.

Exhibits

At the suggestion of a number of the members who went to the conference in Boston last year, arrangements had been made to have commercial exhibits in operation during this convention. There were 44 booths and 41 exhibitors. Their displays included the following items: 16mm motion-picture projectors; 35mm still-picture projectors; opaque projectors; details about motion-picture film libraries; sources of 35mm film strips; 16mm reels; tape recorders; printing materials; disc records; library services; room-darkening materials; equipment for handling, marking and storing films; and projection screens.

A report received on March 17, 1953.

* D. F. Lyman, "Audio-Visual Conference," *Jour. SMPTE, 58:* 445–449, May 1952.

Program

Because of the way the conference was operated, the program is a major work in itself. It consists of a 5 × 7½ inch booklet with 41 printed pages. It shows the sequence of preconference and conference meetings, the topics discussed in the separate meetings of the 13 sections, the chairmen and recorders of all the meetings, long lists of "resource leaders" for the section meetings, the exhibitors and the layout of their space, and general information about the convention and the department. The great deal of work which must have gone into the booklet was a worthy effort, for it was one of the chief reasons for the smooth running of the convention.

As at the previous convention, there were a few general sessions for the entire group of registrants, but much of the time was devoted to separate meetings of 13 discussion groups sponsored by national committees or sections. These committees, which are responsible for continual progress in their particular endeavors throughout the following year, receive a great deal of help from the ideas and suggestions expressed in the discussions held during the conventions. Brief reviews of some of the general sessions and section meetings are given below.

General Sessions

The first general session was a presentation of a selected group of films which had been rated as outstanding at recent European film festivals.

At the main dinner meeting, the speaker was R. J. Blakely from the fund for Adult Education of the Ford Foundation. He described the investigations that are being made to determine how television can be applied most effectively in educational work, and the relation of television to other forms of mass communication such as newspapers, films, radio and picture magazines.

In his president's message, J. W. Brown spoke of the continued growth of the DAVI organization, which had 1066 members in 1951, 1381 in 1952, and now has 1755 in 1953.

On Thursday morning, a still-picture film in color was presented with accompanying sound on magnetic tape. It described and showed an experiment conducted in a Cleveland school located in an underprivileged area. Rapid advances were made by children of pre-reading age when audio-visual work on the subject of farms, presented over a period of several weeks, was supplemented by a field trip to a farm. Questions and answers recorded before, during, and after the experiment showed that the pupils made substantial general progress, as well as learning a great deal about farms and farmers.

At this same meeting, Maurice Ahrens spoke on "The Role of Instructional Materials Specialists in Curriculum Development Programs." He outlined the transitions that have taken place in the development of curriculums, from textbooks alone to specialists in that type of work, then to teacher committees, and finally to the more modern method that stresses development of a curriculum to suit each individual school. He emphasized that the materials specialist and the materials laboratory should take a leading role in the operation of this most recent method. He believes that each school should have its own laboratory, but that the work of the individual laboratories should be correlated by a central laboratory, which is in a better position to plan budgets, for example. A materials specialist will find it necessary to work with groups of teachers in order to spread his efforts effectively. Furthermore, he should help with plans for buildings, so that audio-visual aids can be used to their full advantage, work with principals and other consultants and specialists, provide a workshop and a community resource file, and facilitate the use of his materials. The facilities and functioning of such a center were illustrated by a 16mm film based on the school system of Corpus Christi, Texas.

At another general session, a panel of speakers under the chairmanship of F. E. Brooker described some of the international developments in the audio-visual field. Reports were made by DAVI members who have served abroad in the Mutual Security Agency or Point Four organizations. Included was the work done in the Philippines, France, Iran, Israel and India, as well as some of the coordinating work in Washington, D.C. A teacher from the Philippines and a student from Egypt gave further descriptions of audio-visual plans in their countries.

Field Trip to Audio-Visual Center

One of the best features of the convention was the open house at the Audio-Visual Education Building of the Division of Audio-Visual Education for the St. Louis public schools. There was ample opportunity to visit all the departments of this large audio-visual center and to talk with the hospitable members of its staff. In addition to the libraries, museums, laboratories and storage rooms, the building houses station KSLH, an FM radio station being operated as a part of the city's educational system. Sample films to

show how local subjects can be kinescoped and photographed for use on educational television programs were shown, respectively, by A. L. Hunter of Michigan State College and John Whitney of the St. Louis schools.

Section Meetings

Of the 13 Sections meeting during the week, Section 8, Buildings and Equipment, which the writer attended, is more closely allied than any of the others with the work of the Society of Motion Picture and Television Engineers. This Section considered a draft of a booklet on Audio-Visual Centers. This is the third to be published. No. 1 is *Classrooms*,* while No. 2, just issued, is *Auditoriums*. Although no final drafts were drawn during the meetings, there was a great deal of discussion about the following points: the scope of the booklet under consideration, ways to insure positive action in securing audio-visual centers, the functions the center must fulfill, how different schools and school systems should be covered, the distinction between an "audio-visual center" and an "instructional materials center," the advantages and disadvantages of providing sample floor plans that would show architects how much space is needed for each function, the respective responsibilities of a coordinating center and a local center, how both types should be administered, how plans can be made for future growth and new materials, the best climatic conditions for "caring for" equipment and materials, and the needs of those who are being called upon to change from a single-system building center to a central system that coordinates the work of a number of building centers. At times, the discussion seemed to show many points of difference, but when it is analyzed, it should be of great assistance to the small group that will write the next drafts of the booklet.

Most of the sections had previously solicited the aid of "resource leaders" who had agreed to serve in that capacity and were called upon for suggestions. That method, and the frequent use of a panel of speakers in the general sessions, serves to enlist the capabilities of experts who otherwise might not be heard. This idea has interesting possibilities. In the case of resource leaders, more specific results could be obtained if each person were assigned — or voluntarily assumed — some particular phase of the work.

* Ann Hyer, "Planning classrooms for audio-visual materials," presented on October 7, 1952, at the Society's Convention at Washington, D. C., and scheduled for early *Journal* publication. *Classrooms* was reviewed in the Sept. 1952 *Journal*, and *Auditoriums* in April 1953.

Theater Survey

The eruption of technical innovations in the production and exhibition of motion pictures has given rise to a certain degree of confusion and hesitation. The last 25 years have witnessed the development of sound and color and the beginnings of theater television. In the space of less than a year the industry has been swamped by Cinerama, 3-D, stereophonic sound, aspect ratios increased from 4:3 to 5:3, $5\frac{1}{2}$:3, talk of 6:3 and CinemaScope $7\frac{2}{3}$:3. These are being advocated singly and in various combinations.

However there are several "unknowns" in these equations. Possibly of major significance is the question of structural limitations. Stated more fully, what shapes and sizes of pictures can be economically exhibited in enough theaters to become the practical basis for future standards? Also vital, is a statistical evaluation of the response of exhibitors to these developments whose adoption necessitates new financial investments. Theater owners, producing companies, equipment manufacturers and dealers, engineers and architects, all are concerned with the answers to these questions.

To secure effectively this desired information the Society's Theater Engineering Committee, with the cooperation of the Motion Picture Research Council, initiated at its last committee meeting, April 30, 1953, a Theater Survey. The complete text of the survey questionnaire is published on the following pages. Distribution of the questionnaire, begun May 25, 1953, was made through the cooperation of the following trade organizations: Motion Picture Association of America, Theater Owners of America, Independent Theater Owners of America, Metropolitan Motion Picture Theaters Association, Allied States Association Theater Owners of America, Theater Equipment Dealers Association; also the following companies: National Theater Supply Company, Altec and RCA Service Companies and several large theater circuits; and also upon request, directly to individual theaters as a result of the wide interest generated through nationwide publicity.

Despite the seemingly haphazard distribution pattern, plans have been made to analyze the returns on a scientific basis giving due weight to such factors as geography, population density, seating capacity, distribution pattern of the different-sized theaters, etc. It is hoped thereby to come up with answers which are applicable industry-wide. After a sufficient number of returns (500 to 1000) are received to build up a valid statistical sample, the survey results will be published as a committee report in this *Journal*. It is expected that this will help eliminate the confusion and hesitation and will provide a firm foundation for many of the important decisions yet to be made.—*Henry Kogel*, Staff Engineer.

May 25, 1953

Theater Screen Survey

With the present great interest in new forms of motion pictures, the producers, the exhibitors and the equipment suppliers are faced with many major decisions. In order that certain of these decisions may be based on facts not now available, the Theater Engineering Committee of the SMPTE is conducting this survey. It is hoped to present the replies from a large cross section of exhibitors in a tabular and graphic summary; individual information will not be publicized.

Since this study is of urgent importance to the whole motion-picture industry, your prompt reply will be appreciated.

The first two questions relate to 3-D pictures by means of the simultaneous projection of two prints for viewing through polarizing glasses:

1. Is your theater already converted for the exhibition of 3-D pictures? Yes______ No______
2. If not, do you plan to convert during 1953? Yes______ No______
3. Have you recently increased the size of your screen to provide for "wide-screen" projection? Yes______ No______
4. If not, do you plan to install a larger screen during 1953? Yes______ No______
5. Seating capacity: Orchestra (main floor) . . . . ______
   Stadium . . . . ______
   First balcony . . . . ______
   Second balcony . . . . ______

Total seats __________

6. Size of present picture (inside of masking) . . . . Height________ Width________

7. Focal length of projection lens . . . . ____________

8. Projection angle, in degrees . . . . ____________

9. If location of projection booth differs from that shown in side view, Drawing 2 or 3, please sketch in position of booth, including height of projection port above floor level.

10. Fill in all obtainable dimensions on Diagrams 1 and 2 for theater without balcony, or 1 and 3 for theater with balcony.

11. Indicate any special conditions in your theater:

Best of all, if you have architects' drawings of the main floor plan and the front-to-back cross section of the auditorium, photostats or other copies of them would be of great value to the Committee in making this detailed study.

Name of theater ________________________

Address ________________________

Name of circuit, if any ________________________

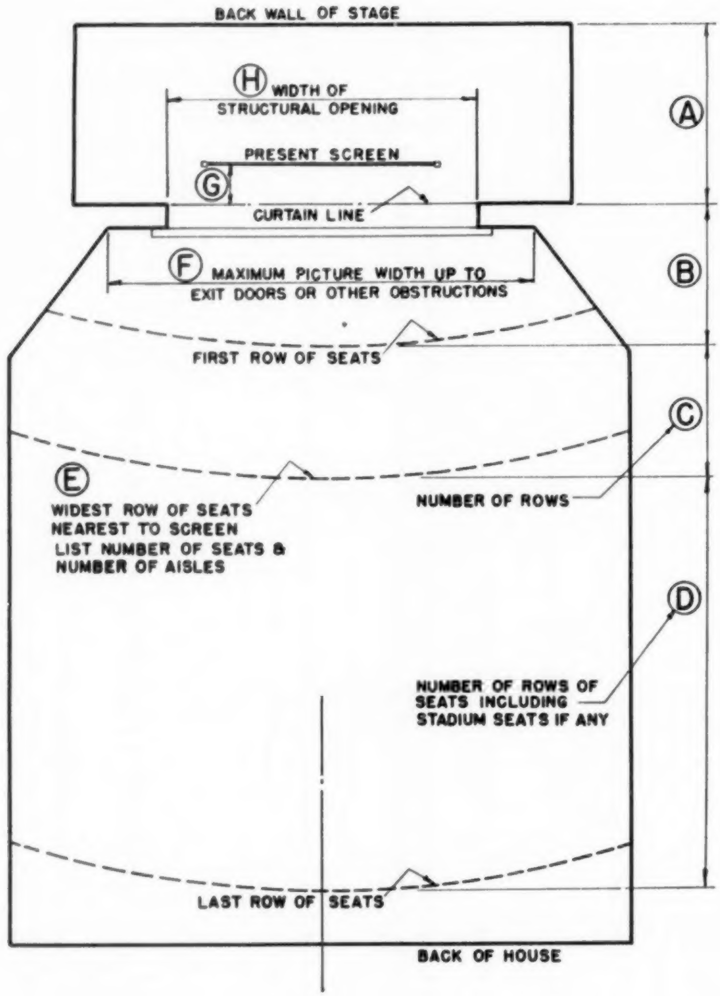
Your name and title ________________________

Date ____________

If you want, keep a copy of this questionnaire, but please be sure to return one copy to:

Henry Kogel, Staff Engineer
Society of Motion Picture and Television Engineers
40 West 40th St., New York 18, N.Y.

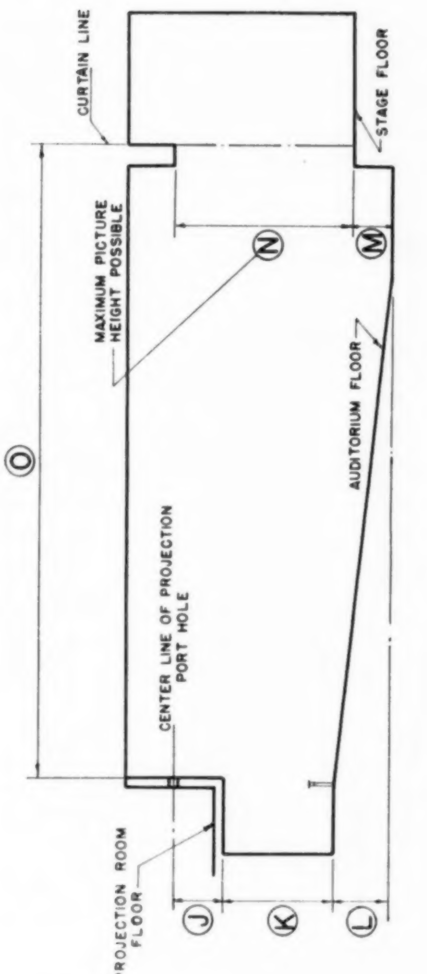
S M P T E Committee on Theater Engineering



ORCHESTRA

A	______		______ AISLES
B	______	F	______
C	______ ROWS	G	______
D	______ ROWS	H	______
E	______ SEATS		

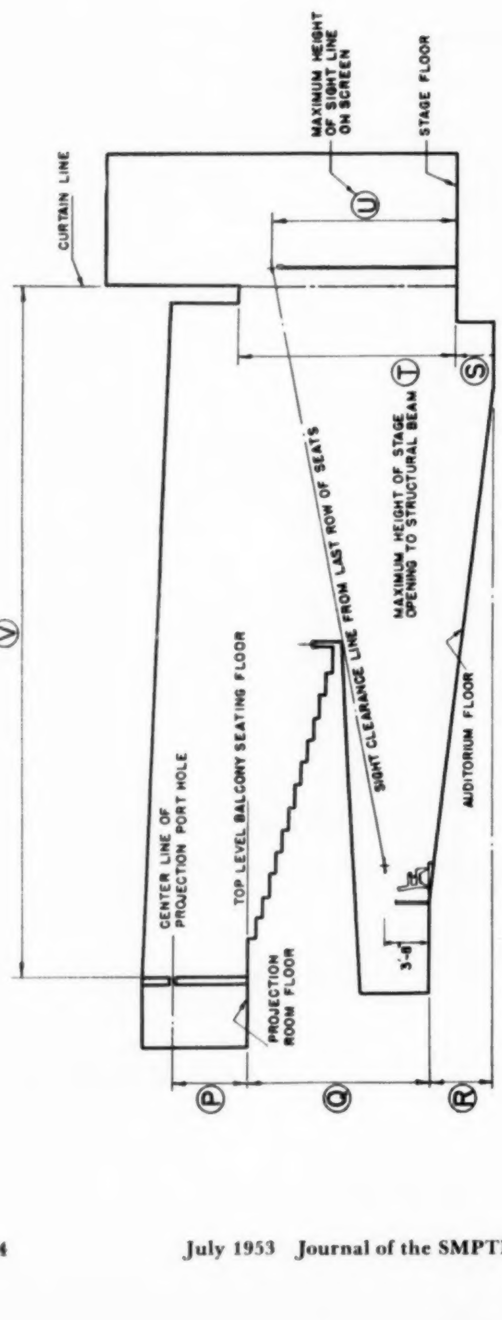
DIAGRAM Nº. 1



SIDE VIEW WITHOUT BALCONY

J ______ M ______
K ______ N ______
L ______ O ______

DIAGRAM No. 2



SIDE VIEW WITH BALCONY

P ______ S ______
Q ______ T ______
R ______ U ______
V ______

DIAGRAM No. 3

74th Convention

On October 5–9 at the Hotel Statler in New York will be presented a program of technical papers now being assembled by Skip Athey. If you have, or know about, a subject which should be on the program, wire or telephone anyone on the list below or anyone on the Papers Committee roster given in the April *Journal*. A substantial number of papers is already arranged, but no worthy paper is as yet too late.

Chairman: W. H. Rivers, Eastman Kodak Co., 342 Madison Ave., New York 17.
74th Program Chairman: Skipwith W. Athey, c/o General Precision Laboratory, 16 South Moger Ave., Mt. Kisco, N.Y.
For Washington: J. E. Aiken, 116 No. Galveston St., Arlington 3, Va.
For Chicago: Geo. W. Colburn, 164 N. Wacker Dr., Chicago 6, Ill.
For Canada: G. G. Graham, National Film Board of Canada, John St., Ottawa, Canada
For 74th Convention High-Speed Photography: Charles A. Jantzen, Photographic Analysis Co., 100 Rock Hill Rd., Clifton, N.J.
For Hollywood: Ralph E. Lovell, 2743 Veteran Ave., West Los Angeles 64, Calif.
For High-Speed Photography: John H. Waddell, 850 Hudson Ave., Rochester 21, N.Y.

Membership Service Questionnaire Analysis

The membership service questionnaire which went out in January along with annual dues bills to all members in the U.S., except students, drew a response from 1296, or 44.1% — a high return as such questionnaires go. The replies of the membership were the basis for the SMPTE Board of Governors' action reported in the June *Journal* — chiefly that of authorizing a 20% increase in the size of the *Journal*. In response to membership demands for more tutorial and "how-to" papers, Editorial Vice-President Norwood Simmons has instructed the Papers Committee to apply greater effort in that direction.

Comments or suggestions relating to *Journal* practices are in order at any time. However, after looking through the analysis, members may well feel prompted to express their personal point of view. In this connection open letters will be welcomed by Norwood Simmons, 6706 Santa Monica Blvd., Hollywood 38, Calif.

The questions as they appeared in the questionnaire are shown below in boldface type, with tabulation by number of members and by percentage of the total of 1296 replies.

THE JOURNAL AND THE SOCIETY'S ACTIVITIES

1. Do you find the Journal satisfactory as it is?

Yes	No	Partly	No Opinion
900 (69.4%)	67 (5.2%)	115 (8.9%)	214 (16.5%)

If you think that improvements should be made, would you say that:

(a) articles are too obscure or technical?

Yes	No	Partly	No Opinion
172 (13.4%)	166 (12.8%)	85 (6.5%)	873 (67.3%)

(b) **articles should be more technical?**

Yes	No	Partly	No Opinion
78 (6.0%)	195 (15.1%)	26 (2.0%)	997 (76.9%)

(c) **the Journal would be more useful if it contained more "how to" papers about TV films, magnetic editing, etc.?**

Yes	No	Partly	No Opinion
550 (42.4%)	51 (4.0%)	15 (1.1%)	680 (52.5%)

(d) Journal issues should contain more papers?

Yes	No	Partly	No Opinion
251 (19.3%)	115 (8.9%)	13 (1.1%)	917 (70.7%)

2. What general criticism of the Journal can you offer and what suggestions would you make for improving it?

I. *GENERAL*

A. Subject Matter

A general evaluation of comments shows a marked preoccupation with the balance between the cinematographic and television fields. The membership asks for treatment of the interrelated aspects of both fields with emphasis, on the one hand, on problems and developments in production, processing and projection of motion-picture film for television applications and, on the other, on television techniques making use of cinematographic products and skills.

B. Manner of Presentation

The overwhelming demand is for descriptions and discussions that have practical application to members' own experience and work in the field. The membership asks for papers that are technical, but not purely theoretical, and written in a form acceptable to the greatest number. This means the avoidance, in so far as is possible, of detailed scientific theory, especially mathematical, and concentration on useful principles expressed in clear and simple language.

II. *SPECIFIC*

In the following listing of specific comments the order reflects in general the frequency with which the comment appears. Those most frequently occurring have been emphasized by a figure in parenthesis showing the actual number of times the comment was made.

A. The content of the Journal should:

1. be presented in a form designed to be of the greatest practical use to the majority of members, avoiding abstruse theory and emphasizing clarity and simplicity (36);
2. include more and better photographs and diagrams (26), use color where possible (5);
3. put more emphasis on techniques and developments in the television field, with particular attention to those aspects involving motion picture applications (33);
4. devote more space to new products and developments, with evaluation (24);
5. include more information on three-dimensional films (18);
6. give preference to cinematographic aspects of both motion-picture work and television (19);
7. emphasize practical production problems rather than discussions of scientific and engineering data (10); in particular, information should be given that would be helpful to the work of small production units (4);
8. have more diversified coverage (7);
9. give more attention to audio problems (7);
10. consider theater and projection problems so as to be of practical assistance to exhibitors (7);
11. include tutorial articles designed to appeal to students and non-engineers (6);
12. give more attention to discussion of aesthetic standards (4);
13. give more attention to the following: (a) color cinematography; (b) reversal films for television; (c) foreign techniques, processes and equipment; (d) film processing and laboratory developments; (e) studio lighting; (f) industrial photography; (g) film recording; (h) electronic solutions; (i) personnel problems of the industry, including union regulations, etc.; (j) techniques of individual jobs in motion-picture and television fields.

B. The content of the Journal should NOT:

1. put so much emphasis on television (18);
2. put so much emphasis on high-speed photography (13);
3. include so many articles on proprietary products written so as to give the impression of being disguised commercials (13);
4. devote so much attention to: (a) film processing; (b) magnetic recording; (c) electronics; (d) military research; (e) acoustics; (f) theater design.

C. The Journal should:

1. publish advertisements (11);
2. present series of articles to cover whole scope of a specific subject from first principles to latest developments (7);
3. include nontechnical summaries in difficult articles; publish better summaries in general (6);
4. provide a glossary of technical terms;
5. in the first part of each article introduce the

subject and summarize the conclusions in non-technical terms;

6. give an annual or semiannual review of important developments in all fields in language understandable to the layman;

7. include reviews and abstracts of foreign publications;

8. publish more book reviews;

9. publish tutorial, "how to" articles separately in special editions or sections;

10. include a question and answer section, with bibliographies;

11. include a section for correspondence, "tips," "time-savers," etc.;

12. give more space to advertising situations available and wanted;

13. publish more discussions at end of papers where possible;

14. make available more special issues with collections of papers on related subjects;

15. publish convention papers separately from the regular *Journal* material (which should therefore be increased);

16. give abstracts of all papers presented at conventions;

17. make available catalogs of motion-picture, television and still-photography equipment;

18. include a section on news of the industry;

19. give more space to letters to the editor;

20. abstract important articles in other publications;

21. abstract highlights of important addresses before all sections of the Society (in editorial section);

22. give space to news of membership and activities;

23. reprint major standards periodically;

24. include editorials;

25. present subject matter arranged in categories;

26. republish earlier important papers;

27. give more information on how members can contribute to committee work and other Society activities;

28. publish photographs and biographies of authors with their articles.

D. General Statements

1. *Journal* should appear on time and reach members during month of publication (21).

2. Convention papers should appear sooner after presentation (6).

3. Timelier advance notice of meetings should be given.

4. Tape recordings of discussions at conventions as well as of papers should be made available.

5. Officer nominations should be more evenly distributed by geographical areas.

6. Format changes might include: (a) size increase to $8^1/_2$ by 11; (b) larger type; (c) rigid cover; (d) better index; (e) bi-monthly publication; (f) loose-leaf reprint service.

7. Send forms soliciting articles to all members.

3. Mark your 1st and 2nd choices for future subject emphasis in the Journal, or make suggestions:

Subject	*1st Choice*	*2nd Choice*	*Suggested*	*Total*
Acoustics	22	26	102	150
Animation	26	18	74	118
Cinematography	92	47	150	289
Color	110	64	155	329
Editing	21	32	89	142
Education	8	19	48	75
Films	11	17	67	95
High-Speed Photog.	61	29	69	159
Lighting	23	52	130	205
New Products	47	53	158	258
Optics	39	64	134	237
Processing	38	48	121	207
Production	28	43	91	162
Projection	35	20	102	157
16mm	80	58	153	291
Sound Recording	109	67	165	341
Sound Reproduction	46	68	130	244
Studios	7	19	74	100
Television	131	85	169	385
Theater	13	11	62	86
Theater Television	27	39	108	174
Stereoscopy (written in)	18	9	32	59

First, it should be noted that the "overlooked" subject of Stereoscopy drew a heavy write-in.

Second, except for "Theater Television," the subject of television was not subdivided, but other portions of the Society's field are generally divided and subdivided — sound, for instance, into recording and reproduction.

A recapitulation of subjects in order of number of total choices is:

1.	Television	385	11.	Theater TV	174
2.	Sound Recording	341	12.	Production	162
3.	Color	329	13.	High-Speed Photog.	159
4.	16mm	291	14.	Projection	157
5.	Cinematography	289	15.	Acoustics	150
6.	New Products	258	16.	Editing	142
7.	Sound Reprod.	244	17.	Animation	118
8.	Optics	237	18.	Films	95
9.	Processing	207	19.	Theater	86
10.	Lighting	205	20.	Education	75
			21.	Stereoscopy	59

CONVENTIONS

4. Do you regularly attend conventions?

Yes	Occasionally	No
146 (11.3%)	68 (5.2%)	177 (13.6%)

No Opinion
98 (7.6%)

Or only when they are held near you?

807 (62.3%)

5. Do you think members would be better served if the customary Spring Convention were replaced by several regional meetings of two-day duration?

Yes	No	Both
539 (41.6%)	366 (28.2%)	6 (0.5%)

No Opinion
385 (29.7%)

If in favor of two-day meetings, list choices of cities:

City	*1st Choice*	*Only Choice*	*Total*
New York	129	60	189
Los Angeles	71	55	126
Chicago	51	27	78
Washington, D. C.	16	..	16
San Francisco	8	3	11
Rochester	9	2	11

Cities receiving a total of 6 to 10 checks were: Atlanta, Boston, Cleveland, Dallas, Detroit and Philadelphia.

Cities receiving a total of 1 to 5 checks were: Albuquerque, Austin, Cincinnati, Denver, El Paso, Fort Worth, Houston, Jacksonville, Kansas City, Lansing, Milwaukee, Nashville, New Haven, Phoenix, Pittsburgh, St. Louis, Salt Lake City, San Antonio and Seattle.

MAGAZINES

Members were asked to check a list of magazines. The tabulation will not be published because the Society cannot supply comparative statistics about trade magazines. It may be said, however, that the results were consistent with subject choices indicated in Item 3 above.

In comparison with the subject coverage of the magazines you have checked, does the SMPTE Journal:

duplicate	11	(0.8%)
(partially duplicate)	10	(0.8%)
adequately supplement	849	(65.5%)
inadequately supplement	95	(7.3%)
(no opinion)	331	(25.6%)
Total	1296	(100%)

PROFESSIONAL SOCIETIES

Single check those of the following to which you belong. Make a second check at those with which a conflict of convention dates would be most serious:

Society	*Two Checks*	*One Check*	*Total*
Acoustical Society of America	14	38	52
American Chemical Society	8	53	61
American Institute of Electrical Engineers	8	59	67
American Physical Society	2	40	42
Audio Engineering Society	11	58	69
Biological Photographic Association	8	20	28
Illuminating Engineering Society	1	14	15
Institute of Radio Engineers	68	189	257
Instrument Society of America	4	18	22
National Electronics Conference	7	29	36
Optical Society of America	17	55	72
Photographic Society of America	20	125	145
Society of Photographic Engineers	22	63	85

There were 38 societies' names written in. Of these, only two attained as much as a total of 10 write-ins each. They were the American Association for the Advancement of Science and the American Society of Photogrammetry.—*D.C.*

Status of Motion-Picture Standards

Standards, withdrawals and proposals are shown below according to their status as of February 1953. The six-month index, published as Part II of the June 1953 *Journal* (p. 761), brings the list as published below up to date.

A "New Index to American Standards and Recommendations," of eight full pages, is available at no charge to all who request it from Society Headquarters, regardless of whether it is to go into a binder. Copies should be obtained to replace earlier indexes in all SMPTE binders of standards.

If you have an SMPTE (3-post) binder and would like to receive advance notice of all future new and revised standards, please advise Society Headquarters.

The complete assembly of heavy binder and the 75 current standards is now available at $15.00 (plus 3% sales tax on deliveries within New York City; or plus $0.50 extra for postage on foreign orders).

Subject		*Vol., page, issue*
Apertures, Camera		
8mm	**Z22.19–1950**	**54:** 501, Apr. 1950
16mm	**Z22.7 –1950**	**54:** 495, Apr. 1950
35mm	**Z22.59–1947***	**50:** 287, Mar. 1948
Apertures, Printer		
16mm Contact (positive from negative)	**Z22.48–1946**	**46:** 300, Apr. 1946
16mm Contact (reversal dupes)	**Z22.49–1946**	**46:** 301, Apr. 1946
35mm to 16mm (16mm positive prints)	**Z22.46–1946**	**46:** 298, Apr. 1946
35mm to 16mm (16mm dupe negative)	**Z22.47–1946**	**46:** 299, Apr. 1946
16mm to 35mm Enlargement Ratio	**PH22.92–1953**	**60:** 72, Jan. 1953
Apertures, Projector		
8mm	**Z22.20–1950**	**54:** 503, Apr. 1950
16mm	**Z22.8 –1950**	**45:** 498, Apr. 1950
35mm Sound	**Z22.58–1947***	**50:** 286, Mar. 1948
Cores for Raw Stock Film		
16mm	**PH22.38–1952**	**59:** 429, Nov. 1952
35mm	**Z22.37–1944**	**47:** 262, Sept. 1946
Density Measurements of Film (includes Z38.2.5–1946)	**Z22.27–1947**	**50:** 283, Mar. 1948
Edge Numbering, 16mm Film	**PH22.83–1952**	**59:** 428, Nov. 1952
Film Dimensions		
8mm	**Z22.17–1947***	**49:** 176, Aug. 1947
16mm Silent	**Z22.5 –1947***	**59:** 529, Dec. 1952
16mm Sound	**Z22.12–1947***	**59:** 531, Dec. 1952
32mm Negative and Positive, Sound	**Z22.71–1950**	**56:** 237, Feb. 1951
32mm Negative and Positive, Silent	**Z22.72–1950**	**56:** 239, Feb. 1951
32mm on 35mm Negative	**PH22.73–1951**	**56:** 685, June 1951
35mm Negative	**Z22.34–1949**	**52:** 358, Mar. 1949
35mm Positive	**Z22.36–1947***	**49:** 179, Aug. 1947
35mm Alternate Positive-Negative	**PH22.1 –1953**	**60:** 67, Jan. 1953

* The asterisk denotes that the standard was in process of revision, as of February 1953.

Subject		*Vol., page, issue*
Film Usage, Camera		
8mm	**Z22.21–1946***	**46:** 291, Apr. 1946
16mm Double Perforated	**Z22.9 –1946***	**46:** 289, Apr. 1946
16mm Single Perforated	**Z22.15–1946***	**57:** 581, Dec. 1951
35mm	**Z22.2 –1946***	**46:** 287, Apr. 1946
Film Usage, Projector		
8mm	**Z22.22–1947***	**49:** 557, Dec. 1947
16mm Double Perforated	**Z22.10–1947***	**49:** 555, Dec. 1947
16mm Single Perforated	**Z22.16–1947***	**57:** 582, Dec. 1951
35mm	**Z22.3 –1946***	**46:** 288, Apr. 1946
Focus Scales, 16mm and 8mm Cameras	**PH22.74–1951**	**56:** 687, June 1951
Lamps, 16mm and 8mm Projectors		
Base-Up Type	**PH22.84–1953**	**60:** 69, Jan. 1953
Base-Down Type	**PH22.85–1953**	**60:** 71, Jan. 1953
Lens Mounting, 16mm and 8mm Cameras	**PH22.76–1951**	**56:** 688, June 1951
Nomenclature, Film	**Z22.56–1947***	**50:** 275, Mar. 1948
Projection Rooms and Lenses	**Z22.28–1946***	**47:** 259, Sept. 1946
Reels		
8mm	**Z22.23–1941***	**36:** 241, Mar. 1941
16mm (corrected)	**PH22.11–1952***	**58:** 535, June 1952
35mm	**Z22.4 –1941***	**36:** 222, Mar. 1941
Reel Spindles, 16mm	**PH22.50–1952**	**59:** 525, Dec. 1952
Release Prints, 35mm	**Z22.55–1947***	**50:** 284, Mar. 1948
Safety Film	**Z22.31–1946***	**47:** 261, Sept. 1946
Screen		
Brightness	**Z22.39–1944***	**58:** 452, May 1952
Dimensions	**Z22.29–1948**	**51:** 535, Nov. 1948
Mounting Frames	**Z22.78–1950**	**54:** 505, Apr. 1950
Sound Transmission	**PH22.82–1951**	**57:** 171, Aug. 1951
Sound-Track Dimensions		
16mm	**Z22.41–1946***	**46:** 293, Apr. 1946
35mm	**Z22.40–1950**	**56:** 114, Jan. 1951
35mm Double Width Push-Pull, Normal	**Z22.69–1948**	**51:** 547, Nov. 1948
35mm Double Width Push-Pull, Offset	**Z22.70–1948**	**51:** 548, Nov. 1948
Splices		
8mm	**PH22.77–1952**	**58:** 541, June 1952
16mm	**PH22.24–1952**	**58:** 539, June 1952
Sprockets		
16mm	**(SMPTE Recommended Practice)**	
35mm	**Z22.35–1947***	**49:** 178, Aug. 1947
Test Films		
16mm 400-Cycle Signal Level	**Z22.45–1946***	**46:** 297, Apr. 1946
3000-Cycle Flutter	**Z22.43–1946**	**46:** 295, Apr. 1946
5000-Cycle Sound Focusing		
7000-Cycle Sound Focusing	**Z22.42–1946***	**46:** 294, Apr. 1946

Subject		*Vol., page, issue*
Buzz-Track	**Z22.57–1947***	**51:** 537, Nov. 1948
Multi-Frequency	**Z22.44–1946**	**46:** 296, Apr. 1946
Travel Ghost	**Z22.54–1946***	**46:** 309, Apr. 1946
Sound Projector	**Z22.79–1950**	**54:** 507, Apr. 1950
Scanning Beam, Laboratory Type (corrected)	**PH22.80–1950**	**59:** 430, Nov. 1952
Scanning Beam, Service Type (corrected)	**PH22.81–1950**	**59:** 430, Nov. 1952
35mm 1000-Cycle Balancing	**Z22.67–1948**	**51:** 545, Nov. 1948
7000-Cycle Sound Focusing	**Z22.61–1949**	**54:** 107, Jan. 1950
9000-Cycle Sound Focusing	**Z22.62–1948**	**51:** 541, Nov. 1948
Buzz-Track	**Z22.68–1949**	**54:** 108, Jan. 1950
Scanning Beam, Laboratory Type	**Z22.66–1948**	**51:** 543, Nov. 1948
Scanning Beam, Service Type	**Z22.65–1948**	**51:** 542, Nov. 1948
Theater Test Reel	**Z22.60–1948**	**51:** 539, Nov. 1948
Test Methods, 16mm Sound Distortion		
Cross Modulation, Variable-Area	**Z22.52–1946**	**46:** 305, Apr. 1946
Intermodulation, Variable-Density	**Z22.51–1946**	**46:** 303, Apr. 1946
Test Plate		
Resolution Target, 16mm Projector	**Z22.53–1946***	**46:** 307, Apr. 1946

Standards Withdrawn

No.	*Title*	*Vol., page, issue*
Z22.6 –1941	Projector Sprockets for 16mm Film	**36:** 224, Mar. 1941
Z22.13–1941	For current standard see Z22.7–1950 Camera Aperture for 16mm Sound Film	**36:** 231, Mar. 1941
Z22.14–1941	For current standard see Z22.8–1950 Projector Aperture for 16mm Sound Film	**36:** 232, Mar. 1941
Z22.18–1941	8-Tooth Projector Sprockets for 8mm Motion Picture Film	**36:** 236, Mar. 1941
Z22.25–1941	American Recommended Practice for Film Splices Negative and Positive for 16mm Sound Film (See PH22.24)	**36:** 243, Mar. 1941
Z22.26–1941	American Recommended Practice for Sensitometry	**36:** 244, Mar. 1941
Z22.30–1941	American Recommended Practice for Nomenclature	**36:** 248, Mar. 1941
Z22.32–1941	Cancelled	**50:** 276, Mar. 1948
	American Recommended Practice for Motion Picture Film, Theater Sound Fader Setting Instructions	**48:** 390, Apr. 1947
	American Recommended Practice for Fader Setting Instructions	**36:** 250, Mar. 1941
Z22.33–1941	(Notice of Withdrawal) American Recommended Practice for Nomenclature for Filters	**59:** 252, Mar. 1941
Z22.63	Proposed, Service-Type Multifrequency Test Film for 35mm Motion Picture Sound Reproducers	**50:** 275, Mar. 1948
Z22.64	Laboratory-Type Multifrequency Test Film for 35mm Motion Picture Sound Reproducers	**50:** 275, Mar. 1948

Proposed Standards

PH22.75	Proposed, A and B Windings of 16mm Single-Perforated Film (Third Draft)	**60:** 189, Feb. 1953
PH22.86	Proposed, Dimensions for Magnetic Sound Tracks on 35mm and 17½mm Motion Picture Film	**57:** 72, July 1951

No.	Title	Vol., page, issue
PH22.87	Proposed, Dimensions for Magnetic Sound Track on 16mm Motion Picture Film	**57:** 73, July 1951
PH22.88	Proposed, Dimensions for Magnetic Sound Track on 8mm Motion Picture Film	**57:** 74, July 1951
PH22.89	Proposed, Printer Light Change Cueing for 16mm Motion Picture Negative (not at Journal publication stage; available as mimeographed proposal)	
PH22.90	Proposed, Aperture Calibration of Motion Picture Lenses	**59:** 338, Oct. 1952
PH22.91	Proposed, 16mm Motion Picture Projector for Use with Monochrome Television Film Chains Operating on Full-Storage Basis (Fourth Draft)	**59:** 144, Aug. 1952
PH22.93	Proposed, 35mm Motion Picture Short Pitch Negative Film	**59:** 533, Dec. 1952
PH22.94	Proposed, Slides and Opaques for Television Film Chains (published April 1953)	

Photographic Apparatus and Processing Standards

Below are listed the numbers and titles of recently approved American Standards in the field of still photography. Additional listings of such standards will be published in the *Journal* from time to time, as they are made available, as a service to those readers who maintain an active interest in still, as well as motion-picture, photography.—*Henry Kogel*, Staff Engineer.

Photographic Apparatus, PH3

Back Window Location for Roll Film Cameras, PH3.1-1952 (Revision of Z38.4.9-1944)

Method for Determining Performance Characteristics of Focal-Plane Shutters Used in Still Picture Cameras, PH3.2-1952 (Replaces American War Standard Z52.65-1946)

Exposure-Time Markings for Focal-Plane Shutters Used in Still Picture Cameras, PH3.3-1952 (Replaces Proposed American War Standard Z52.64)

Method for Determining Performance Characteristics of Between-the-Lens Shutters Used in Still Picture Cameras, PH3.4-1952 (Replaces American War Standard Z52.63-1946)

Exposure-Time Markings for Between-the-Lens Shutters Used in Still Picture Cameras, PH3.5-1952 (Replaces American War Standard Z52.62-1946)

Tripod Connections for American Cameras, ¼-Inch-20 Thread, PH3.6-1952 (Revision of Z38.4.1-1942)

Tripod Connections for Heavy-Duty or European Cameras, ⅜-Inch-16 Thread, with Adapter for ¼-Inch-20 Tripod Screws (Revision of Z38.4.2-1942), PH3.7-1952

Photographic Processing, PH4

Specifications for Sheet Film Processing Tanks, PH4.2-1952 (Revision of Z38.8.15-1949)

Specifications for Photographic Trays, PH4.3-1952

Specifications for Channel-Type Photographic Hangers, Plates and Sheet Film, PH4.4-1952

Specification for Photographic Grade Sodium Acid Sulfate, Fused, ($NaHSO_4$), (Sodium Bisulfate, Fused; Niter Cake), PH4.105-1952

Specification for Photographic Grade Sodium Sulfite, (Na_2SO_3), PH4.275-1952 (Revision of Z38.8.275-1948)

New Test Films

A folder of addenda to the Society's Test Film Catalog is now available at no charge from the Society's headquarters. Details of five new 35mm test films are listed, designed for 3-D and 2-D projector alignment, magnetic 3-track balancing, magnetic 3-track azimuth alignment, magnetic 3-track flutter test and magnetic 3-track multifrequency test. There is also a 16mm magnetic azimuth alignment test film. These films have been approved by technical committees of the Society and of the Motion Picture Research Council.

Theater Television

Only by its appeal will theater television survive, for FCC Docket 9552 is now closed by a finding of June 24, Commissioner Hennock dissenting. The Commission speaks:

"... theatre television should operate as a common carrier on frequencies presently allocated for such services, we of course expect that there will be cooperation among common carriers in resolving frequency conflicts.... There has been no persuasive evidence in this proceeding to the effect that the existing common carrier allocations are not adequate.... In any event, we do not feel this is the proper proceeding to reevaluate the sufficiency of present allocations to the common carrier service.... If the proponents of theatre television feel that existing common carriers cannot supply them with the service they desire, they are free to take the necessary steps to establish a separate carrier ... or to require existing carriers to render a reasonable service.... We recognize [theater television in general] as an existing service which will continue to expand or not depending upon public acceptance and support thereof.... Our concern is merely with the question of whether there should be a separate allocation of frequencies for the exclusive use of this service. Finding that there is no necessity for such an allocation, we have decided that this proceeding should now be terminated." *Note:* Commissioner Hennock believes the hearing incomplete, the finding unwarranted since "public interest" was not specifically determined and, in opposing, draws critical inference that "... this question will be decided when a specific application for service is filed."—*B.N.*

Book Reviews

The Television Manual

By William Hodapp. Published (1953) by Farrar, Straus and Young, 101 Fifth Ave., New York 3, N.Y. i–xiv, 289 pp. text + 5½ pp. index. 5½ × 8¼ in. Not illustrated.

This book, as stated by the publishers, is a "guide to TV production and programming for education, public affairs and entertainment." It is a very good book from this point of view, and is no doubt directed toward that group of workers in television broadcasting who are intimately concerned with the business of building and producing programs to satisfy the insatiable appetite of this demanding new entertainment medium. As a program guide, it fills a real need in the field of television broadcasting.

Although not a technical book in any sense, it will prove of interest to those engineering and technical workers in the field who might feel the need of an authoritative work on television production and programming techniques, and for this purpose it should prove a valuable addition to the tele-

vision engineer's reference library. Because of the author's practical experience with NBC, the information contained in this volume can be considered authoritative as well as practical.

The author discusses program formats and sources, production and operations, studio and remote settings, staging, films for television, educational TV operation, the personnel engaged in producing a complete television program on the air and their various duties and responsibilities. There is an interesting discussion of television today and tomorrow.

A well-prepared appendix provides some very excellent information for new people entering the field of television programming as well as station management. For new television station managers this volume will be a helpful place to find practical information concerning important phases of station operation, typical network costs, standard business contract forms, a glossary of TV production terms, recommended sources of information for further study, etc.

The book would have been vastly improved through the addition of some carefully selected illustrations, and it is hoped that in his second edition the author will make up for this deficiency.—*Scott Helt*, Allen B. Du Mont Laboratories, Inc., 750 Bloomfield Ave., Clifton, N.J.

Designing for TV,

The Arts and Crafts in Television

By Robert J. Wade. Published (1953) by Pellegrini and Cudahy, 101 Fifth Ave., New York 3, N.Y. 203 pp. + 12 pp. index. Numerous illus. 8 × 11½ in. $8.50.

The time is ripe for specialized and definitive books on the various aspects of the new television medium. Television engineering has long since passed from experimentation into practical day-to-day operation, and television production too has borrowed what it must from the techniques of stagecraft, from motion pictures, from display advertising and a dozen other fields, passed through the experimental period and is settling down into a fairly well standardized television technique.

Designing for TV is a book for the set designer, the graphic artist, and naturally for the director as well, since the very intensity of production in this medium demands that everyone have a pretty clear idea of the other man's problems. It will be particularly valuable for the TV station production manager, who must decide on the type of scenery to be built, the space necessary for construction and painting, and must devise short-cut techniques ("nickel-tricks" as Chuck Holden calls them at ABC) to get "almost the same effect" at negligible time and cost. Wade's book is frankly a glamour-book, lavishly supplied with illustrations, many of which seem to occupy a lot of space without conveying too much actual information. Yet the solid stuff is there — and the glamour factor should add greatly to the inspirational value of the book when it falls into the hands of students of the medium.

Although described by the author as a reference book, *Designing for TV* is written in such a personable style that one frequently looks up a subject and finds himself beguiled into reading well beyond his topic. It conveys a feeling of immediate contact with the medium, of getting "the straight stuff right from the horse's mouth" which is invaluable in a book of this kind. Wade is candid in his accuracy: "distemper colors," he reports, "include a palette of hot unpleasant browns, screeching yellows, an assortment of half-caste putty gamboges and pinks . . . a rather beautiful turquoise [etc.]." He is honest in his opinions. In discussing the cameo technique, a method of producing dramatic shows largely in close shots with a black background, he has this to say: "While graphic artists for obvious reasons do not cotton to this technical development, the method has many excellent features and provides means of presenting certain types of dramatic fare in an atmosphere of intimacy. The viewer, not always without some embarrassment, is enabled to watch and to eavesdrop at close range during emotional scenes and can observe, if he has the clinical interest, enlargements of varied eyes, ears, noses and throats reacting to different stimuli."

Although priced nearly in the luxury class, this book should have wide usefulness. It belongs in every television library and close at hand on every production man's desk.—*Rudy Bretz*, Television Consultant, Park Trail, Croton-on-Hudson, N.Y.

Home Music Systems:

How to Build and Enjoy Them

By Edward Tatnall Canby. Published (1953) by Harper & Brothers, 49 E. 33d St., New York 16, N.Y., i–x, 296 pp. text + 4 pp. index. Illus. $5\frac{1}{2} \times 8$ in. Price $3.95.

Mr. Canby, who regularly reviews records in *Audio Engineering*, is clearly aiming his book at the considerable audience that follows his reviews and also at the ever-growing number of good-sound enthusiasts interested in choosing and installing their own sound equipment. Primarily intended for the amateur intent on getting the utmost out of his commercial LP records, the book has a store of clearly expressed information on the theory and performance of each component of a sound system — turntables, pickup heads, preamplifiers, amplifiers and speakers — as well as on the various refining gadgets now available to go with them. There is good practical guidance on quality and price of equipment offered on the market, and much helpful advice is given on speaker enclosures and other aspects of home installation. This should be a handy reference book even for the sound engineer, who is all too likely these days to be in frequent demand for informal help with living-room music systems.—*D.C.*

Scientific Film Review

This is a new quarterly of criticism being issued by the Scientific Film Association in London, as a supplement to the *Monthly Film Bulletin* of the British Film Institute. It is distributed to all members of those two organizations and may be obtained by others from the General Secretary, Scientific Film Association, 164 Shaftesbury Ave., London W.C.2. The first issue contained full details on 17 new films, ranging from purely scientific instructional films on electricity to films on engineering, textiles and medicine.

Current Literature

The Editors present for convenient reference a list of articles dealing with subjects cognate to motion picture engineering published in a number of selected journals. Photostatic or microfilm copies of articles in magazines that are available may be obtained from The Library of Congress, Washington, D.C., or from the New York Public Library, New York, N. Y., at prevailing rates.

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An Animation Stand for TV Film Production (p. 162) *W. R. Witherell, Jr.*

The Magnasync Recorder (p. 165) *D. J. White*

The New Ansco Color Film and Process (p. 166) *R. A. Mitchell*

vol. 34, May 1953

2-D, 3-D, Wide-Screen, or All Three (p. 210) *A. Gavin*

Columbia Studio's 3-D Camera (p. 215)

Filming the Big Dimension (p. 216) *L. Shamroy*

Terror in 3-Dimension (p. 218) *H. A. Lightman*

vol. 34, June 1953

Some Basic Principles of 3-D Cinematography (p. 266) *F. A. Ramsdell*

One Camera, One Film for 3-D (p. 269)

A New Camera Dolly for Films and Television (p. 273) *K. Freund*

The Hallen Magnetic Film Recorder (p. 274) *H. Powell*

Audio Engineering

vol. 37, May 1953

Handbook of Sound Reproduction, Chapter 11: Loudspeaker Mounting (p. 34) *E. M. Villchur*

vol. 37, no. 7, July 1953

Handbook of Sound Reproduction, Chapter 12: The Power Amplifier, Pt. 1 (p. 26) *E. M. Villchur*

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A series of installments on "The Story of 3-D from 1613 to 1953" by *Martin Quigley, Jr.* The previous sections of this article were published in the issues of Feb. 7 (p. 16) and Feb. 21 (p. 14)

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Obituaries

Herbert Griffin died on May 6, 1953, at Santa Monica, Calif. He was Vice-President and a Director of International Projector Corp.

Born in London in 1887, he was educated there and in the U.S. and was subsequently associated with several engineering firms. In 1915 he joined Nicholas Power Co., makers of projectors, and, except for an excursion as director of motion-picture activities for the YMCA with the AEF from 1916 to 1919, he stayed with Nicholas Power until the firm merged with International Projector Corp., makers of Simplex projectors. He became Vice-President and a Director of that firm in 1936.

Herbert Griffin will be especially remembered by the Society's members as one active in its affairs for many years. He was President in 1943–44 and a Fellow.

Leopold E. Greiner, Jr., President of Greiner Glass Industries Company of New York, died in May 1953. Mr. Greiner had pioneered in the precision etching of various glass devices for use in motion-picture equipment. He was responsible for the design and production of the widely used 16mm Projector Lens Resolution Target which is based on American Standard Z22.53.

Riborg Graf Mann died at his home in East Hampton, N.Y. on June 13, 1953. He was 52 years old.

After graduation from the Massachusetts Institute of Technology, where he was a member of the Student Army Training Corps of World War I, he entered the radio and motion-picture field. In 1927 he joined the Lee DeForest Laboratories where he performed experimental work on motion-picture sound equipment. In 1928 he traveled extensively for Movietone News, both in this country and abroad, pioneering in the making of sound newsreels. He then transferred to Trans-Lux where he helped build their first Newsreel Theater in New York. For the past 20 years he had been Chief Engineer of Pathe News.

During World War II, Mr. Mann was given a leave of absence from Pathe and served for 36 months in the United States Coast Guard Reserve. He attained the rank of Lieutenant-Commander, commanding a Destroyer Escort both in the Atlantic and Pacific areas.

He had been a member of the Society of Motion Picture and Television Engineers since 1934.

SMPTE Lapel Pins

The Society has available for mailing its gold and blue enamel lapel pin, with a screw back. The pin is a ½-in. reproduction of the Society symbol — the film, sprocket and television tube — which appears on the *Journal* cover. The price of the pin is $4.00, including Federal Tax; in New York City, add 3% sales tax.

New Members

The following members have been added to the Society's rolls since those last published. The designations of grades are the same as those used in the 1952 Membership Directory.

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Vellani, Antonio, University of Southern California. **Mail:** 2036 North Beachwood, Hollywood 28, Calif. **(S)**

Vlack, Robert C., University of Southern California. **Mail:** 2258 Luana La., Montrose, Calif. **(S)**

Ward, Richard H., Television Technician, WRGB, General Electric Co., 60 Washington Ave., Schenectady, N.Y. **(A)**

Watkins, Richard, Northwestern University. **Mail:** 4654 Milwaukee Ave., Chicago 30, Ill. **(S)**

Wells, Clifford, Machinist, Ace Film Laboratories, Inc. **Mail:** 2105 Avenue Z, Brooklyn 35, N.Y. **(A)**

West, George R., University of Southern California. **Mail:** 5629 Ensign St., North Hollywood, Calif. **(S)**

Widing, C. George, Laboratory Engineer. **Mail:** 8764 Beverly Blvd., Los Angeles, Calif. **(A)**

Williams, Fred G., Assistant General Manager and Vice-President, Consolidated Amusement Co., Ltd., 25 Taylor St., Suite 706–8, San Francisco 2, Calif. **(A)**

Wisniewski, Ray, University of Southern California. **Mail:** 804½ El Centro, Los Angeles, Calif. **(S)**

Wolfman, Augustus, Editor, Photography Publishing Corp., 251 Fourth Ave., New York 10, N.Y. **(A)**

Wood, Capt. Richard A., Army Pictorial, Signal Corps. **Mail:** 3311 Fordham Rd., Academy Gardens, Philadelphia 14, Pa. **(A)**

Woolery, Adrian D., Motion-Picture Producer, Playhouse Pictures, 749 North Highland Ave., Los Angeles, Calif. **(A)**

Yamin, Robert H., TV Productions, ZIV Television Programs, 5255 Clinton St., Los Angeles, Calif. **(A)**

Young, John W., Lecturer, Motion-Picture Division, University of California. **Mail:** 10551 Scenario La., Los Angeles 24, Calif. **(A)**

Zacarias, Ruben, University of Southern California. **Mail:** 4317 Kenwood Ave., Los Angeles 37, Calif. **(S)**

Zuber, James, University of Southern California. **Mail:** 10415 South Noover St., Los Angeles, Calif. **(S)**

DECEASED

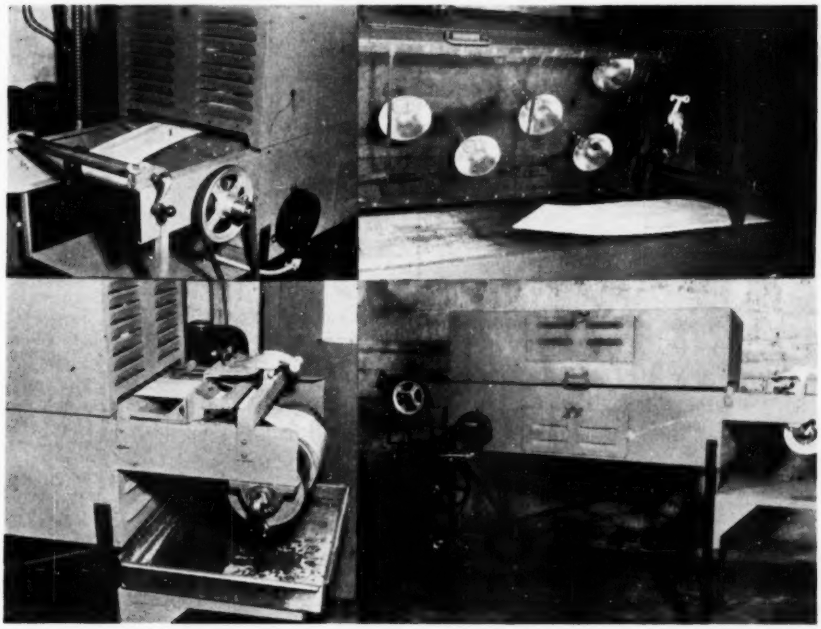
Griffin, Herbert, Vice-President, International Projector Corp. **Mail:** 1615 Cordova St., Los Angeles 7, Calif. **(F)**

Mann, Riborg G., Chief Engineer, Pathe News, Inc., 625 Madison Ave., New York 22, N.Y. **(M)**

SMPTE Officers and Committees: The roster of Society Officers and the Committee Chairmen and Members were published in the April *Journal*.

New Products

Further information about these items can be obtained direct from the addresses given. As in the case of technical papers, the Society is not responsible for manufacturers' statements, and publication of these items does not constitute endorsement of the products.

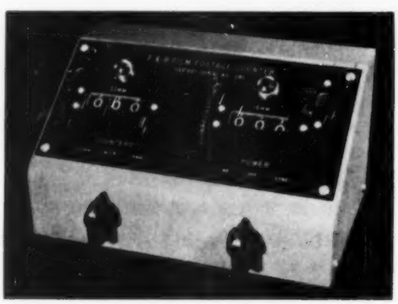


The Metlen Dryer, to process photographic recording paper more quickly, rather than more slowly, than it is used, has been developed and placed on the market by the Metlen Manufacturing Co., P.O. Box 2186, Seattle, Wash. Formerly, 200-ft lengths of from one to 20 rolls were exposed in an 8-hr day, but took 2 to 3 days to process. This dryer will dry a 200-ft roll of photographic recording paper in 10 to 16 min, depending on the width and type of paper.

After being developed, the wet paper is wound on a large spool at the receiving end of the dryer. From this spool the paper is run through squeegies and then between the drying chambers to a rewind core, which is driven by a 1/10-hp 110-v electric motor with a resistor control to determine drying speed, regulated according to width and quality of paper. After it is dried the roll of paper is slipped off the core.

All metal parts of the squeegies which remove the surplus water from the paper are of stainless steel. The drying chambers between which the paper travels have an arrangement of eighteen 375-w 110-v commercial drying bulbs. The paper travels between these two heat chambers held in place by a drying screen of fine-mesh stainless steel. The top half of the dryer is fluted so as to create heat and moisture circulation, vaporizing the moisture and removing it with the excess heat from the drying chamber. The free flow of moisture and heat from the dryer results in the short drying period.

The Kelly Cine Calculator is designed to provide in compact and easily operable form a means for establishing such 35mm cinematography data as these: (on front side, shown above) hyperfocal distance and depth of focus; (on reverse side, not shown) film speed per second; aperture scales (T-stops have been added for the users' convenience and are based on existing Technicolor-to-*f* stop values; it is not claimed that they necessarily represent absolute transmission values); filter factors, camera speed-to-aperture; shutter angle-to-aperture; field of view; key-light and many other factors. The Calculator comes in two models: one for 35mm which is also useful for Leica, Contax and minicam fans; and another for 8-16mm. List price is $3.95, including complete instruction manuals. Made in England, sole distributors for U.S. and South America are Florman & Babb, 70 W. 45 St., New York 36.



The F &B Film Footage Counter has been introduced by Florman and Babb, 70 West 45th St., New York 36, N.Y. The dual model is a re-settable, synchronous film counter in 16mm and 35mm, on which either one or both may be selected by a switch. Monitor lights indicate whether the counter is in operation. With another selector, the unit can be switched to either "Sync" or "Line" position. In "Sync" position, the selector by-passes other switches in the unit, thus giving free way and interlocking with the synchronous

power supplied by a projector, a dubber, etc. In "Line" position the unit will be manually started and stopped by a small On-Off switch.

On the back plate of the unit, a standard-sized receptacle will furnish a 110-v 60-cycle sync line for a minute and seconds counter, cueing signal, script reading light or other accessories.

In order to assure a smooth and quiet drive, the high torque, low-speed synchronous motors are nylon geared and equipped with special lubricants. The unit starts and stops within 1 cycle ($^1/_{60}$ sec).

Florman & Babb are also introducing small single 16mm and 35mm footage counters with simplified construction, as well as a time counter unit which reads up to 99 min and 59 sec. This time counter can be plugged in to any of the dual or single footage counter units for complete footage and time readings.

Employment Service

These notices are published for the service of the membership and the field. They are inserted for three months, and there is no charge to the member.

Positions Available

Wanted: Motion-picture processing technicians for employment at U.S. Naval Ordnance Test Station, China Lake, Calif. Operators of Models 10 and 20 Houston motion-picture processing machines, and operators of Bell & Howell Models "D" and "J" motion-picture printers are needed. Civil Service positions — $3,410 per annum base pay. Family housing limited; single persons preferred. Obtain Form 57 from any U.S. Post Office, fill out in detail, and mail to Carlos H. Elmer, 410B Forrestal, China Lake, Calif.

Senior Engineer with leading supplier of motion-picture and TV equipment is looking for an associate in the development of film and tape handling equipment and other fine electromechanical devices. Give résumé of professional experience and range of interest and accomplishments by letter to W. R. Isom, 1203 Collings Ave., Oaklyn, N.J.

Wanted: Two design engineers, must be familiar with camera and precision instrument design. A working knowledge of machine shop practice essential. Salaries commensurate with ability. Send résumé of experience and personal details in letter to: Land-Air Inc., 900 Pennsylvania Ave., Alamogordo, N.M.

Wanted: Optical Engineer for permanent position with manufacturer of a wide variety of optics including camera objectives, projector, microscope and telescope optics, etc. Position involves design, development and production engineering. Send résumé of training and experience to Simpson Optical Mfg. Co., 3200 W. Carroll Ave., Chicago 24, Ill.

Wanted: Personnel to fill the 4 classifications listed below, by the Employment Office, Atten: EWACER, Wright-Patterson Air Force Base, Ohio:

Film Editor, GS-9: Must have 5 yrs. experience in one or more phases of motion-picture production. Experience must include at least 1½ yrs. motion-picture film editing with responsibility for synchronization of picture, narration, dialogue, background music, sound effects, titles, etc. $5060 yr.

Photographic Processing Technician (Color) GS-7: 6 yrs. progressively responsible experience in motion-picture photography and/or photographic laboratory work, involving essential operation of film processing. Eighteen months of this experience must have involved processing of color film. $4205 yr.

Photographic Processing Technician (Black-and-White) GS-7: 6 yrs. progressively responsible experience in motion-picture photography and/or photographic laboratory work, involving essential operation of film processing. $4205 yr.

Photographic Processing Technician (Black-and-White) GS-5: 2½ yrs. progressively responsible experience in motion-picture photography and/or photographic laboratory work, involving essential operation of film processing. $3410 yr.

Positions Wanted

TV Cameraman-Director, year's experience as cameraman, asst. stage manager and lighting director; manager, small studio and director of 15-min fill-in TV shows, up to 5 shows weekly, mostly educational TV programs, also daily illustrated newscast, at LR3 Radio Belgrano TV, Buenos Aires, Argentina. Experienced in still and live commercials. Born in U.S., age 26, single, B.A. Hunter College (1951). Veteran, World War II. Desires position with TV station anywhere in U.S. or Latin America; willing to travel. Fluent Spanish. Particularly interested in educational TV, nevertheless, will accept any type of TV work related to experience offered. References, résumé, etc., available on request. Write *airmail* to Stanley E. Lustberg, Jose Everisto Uriburu 1551, Buenos Aires, Argentina.

Picture Optical Printer Available With Operator: Modern complete machine 35mm to 35mm and 16mm to 35mm using Acme Projector and Camera, registration to 0.0001 in., including many accessories, synchronizers, etc. Over 200 TV commercials, many features and blowups in color and B&W. Represents $20,000 investment. Owner-operator has long experience with Hollywood major studios. Can double as cameraman. Reasonable. Contact Wm. G. Heckler, 245 West 55 St., New York, N.Y. Phone: Plaza 7-3868.

Meetings

WESCON (Western Electronic Show & Convention), Aug. 19–21, Civic Auditorium, San Francisco

Biological Photographic Association, 23d Annual Meeting, Aug. 31–Sept. 3, Hotel Statler, Los Angeles, Calif.

Illuminating Engineering Society, National Technical Conference, Sept. 14–18, Hotel Commodore, New York, N.Y.

The Royal Photographic Society's Centenary, International Conference on the Science and Applications of Photography, Sept. 19–25, London, England

National Electronics Conference, 9th Annual Conference, Sept. 28–30, Hotel Sherman, Chicago

74th Semiannual Convention of the SMPTE, Oct. 5–9, Hotel Statler, New York.

Audio Engineering Society, Fifth Annual Convention, Oct. 14–17, Hotel New Yorker, New York, N.Y.

Theatre Equipment and Supply Manufacturers' Association Convention (in conjunction with Theatre Equipment Dealers' Association and Theatre Owners of America), Oct. 31–Nov. 4, Conrad Hilton Hotel, Chicago, Ill.

Theatre Owners of America, Annual Convention and Trade Show, Nov. 1–5, Chicago, Ill.

National Electrical Manufacturers Association, Nov. 9–12 Haddon Hall Hotel, Atlantic City, N.J.

The American Society of Mechanical Engineers, Annual Meeting, Nov. 29–Dec. 4, Statler Hotel, N.Y.

American Institute of Electrical Engineers, Winter General Meeting, Jan. 18–22, 1954, New York

National Electrical Manufacturers Assn., Mar. 8–11, 1954, Edgewater Beach Hotel, Chicago, Ill.

75th Semiannual Convention of the SMPTE, May 3–7, 1954, Hotel Statler, Washington

76th Semiannual Convention of the SMPTE, Oct. 18–22, 1954 (next year), Ambassador Hotel, Los Angeles

77th Semiannual Convention of the SMPTE, Apr. 17–22, 1955, Drake Hotel, Chicago

78th Semiannual Convention of the SMPTE, Oct. 3–7, 1955, Lake Placid Club, Essex County, N.Y.

The Seventh Congress of the International Scientific Film Association will be held September 18–27 in the National Film Theatre and Royal Festival Hall, London S.E.1. A Scientific Film Festival will be held, and in addition, meetings will be held by the Permanent Committees on Medical, Research, Technical and Industrial Films. There will be special sessions on the technique and application of films in medicine.

Society of Motion Picture and Television Engineers

40 West 40th Street, New York 18, N. Y., Tel. LOngacre 5-0172
Boyce Nemec, *Executive Secretary*

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Technicolor Motion Picture Corporation
Terrytoons, Inc.
Theatre Holding Corporation
Titra Film Laboratories, Inc.
United Amusement Corp., Ltd.
Westinghouse Electric Corporation
Westrex Corporation
Wilding Picture Productions, Inc.
Wollensak Optical Company